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IMPROVED HYDRAULIC FLANGING AND STRAIGHTENING MACHINE.

BOILER plates have been successfully flanged by hydraulic pressure for many years past, and we have frequently referred to hydraulic flanging machines in these columns. Their construction has hitherto rendered it necessary to make dies and blocks capable of flanging the plate in one operation or squeeze, this entailing a considerable outlay in blocks and matrices. Up to the present these machines are chiefly used either by railway companies, such as the London and North-Western Railway Company, Crewe; the North-Eastern Railway Company at Gateshead, or such leading firms of locomotive builders as Messrs Beyer, Peacock & Co., Manchester; Neilson & Co., Glasgow, etc.

In no case is good flanging more necessary than in marine boilers, and no firm has a higher reputation for this class of work than the Wallsend Slipway Company, of Newcastle-on-Tyne. The very complete and careful experiments relative to steel boilers made at this company's works were fully described by Mr. Boyd, their managing director, in the paper read before the Institution of Mechanical Engineers some time ago. Having once satisfied themselves that steel was suitable for marine boilers, the firm turned their attention to improving the machinery for working it. As has been recently stated by Mr. Marc Berrier Fontaine, Mr. Tweddell's system of hydraulic machine tools has in France proved peculiarly suited for working in steel. All the riveting at Wallsend is done on Tweddell's system, and the flanging and straightening machine we now illustrate is another application of the system to shop tools. The first object being to reduce the cost of the dies and blocks, it was decided to flange the plates gradually, or step by step, following as nearly as possible to the process of hand flanging. The annexed diagrams show the mode of working, and the two perspective drawings show the machine as in use at the Wallsend Slipway Company's works.

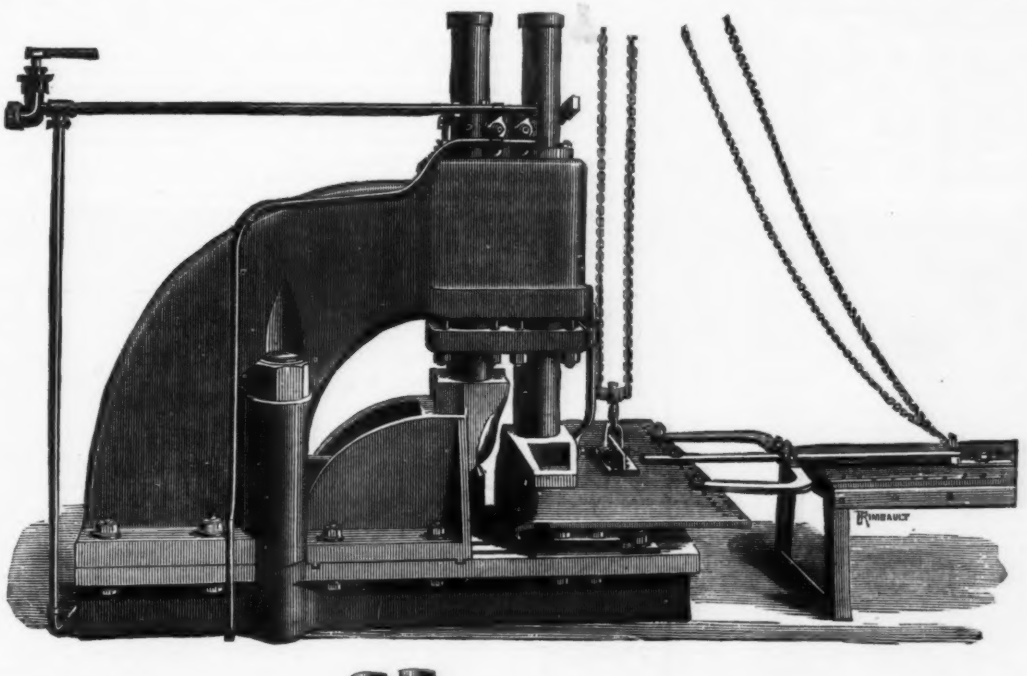
We will suppose it is required to flange the front or back end plate of a marine boiler, the plate to be of steel and 11/16 in. thick, with a flange 7½ in. deep. In Fig. 3, A is a standard attached to the bedplate, B B; the former carries three hydraulic cylinders, C, D, and E, and to the latter is fixed the small block, F, and, when large circular plates are being flanged, the center pin, G. The plate having been heated for a length of from 4 ft. to 5 ft. along its edge, is placed on the block, F, which is merely a segment of a circle with a radius equal to that of the boiler front for which the plate is intended. On the plate being placed on this anvil or block, the hydraulic ram, C, is lowered down upon it; this acts as a "vise" or holder up, and prevents the plate being dragged forward, when it is turned over, as shown in Fig. 3, by the descent of the ram, D. This ram carries a specially shaped tool for turning the edge of the plate over the end of the block or anvil. This operation being finished, the ram, D, is again raised to the position shown in Fig. 3, and, the vise ram also being released, the whole plate, H, is turned round on the center pin, G, and thus presenting a further length to be turned over; the above operation is repeated until the whole length heated is flanged.

Up to the present the length flanged in one heat is 4 ft., but this could easily be increased to 5 ft. or 6 ft., if the heating furnace were made long enough. As soon as the whole length is turned over, the plate is again turned round on its center, G, and the ram, D, being raised up out of the way, the horizontal ram, E, fitted with a hammer head, then advances and straightens and squares up the flange against the anvil, P, thus completing the operation.

It is evident, from this description, that the block or anvil may be made to suit any irregular shape of plate, and when the flanges are straight, of course the center pin, G, is not used; it will be seen in the perspective view that at Wallsend this pin is arranged in a temporary but very efficient manner. There is, however, a great deal of flanging in the marine boilers, in addition to the boiler shell fronts and backs.

Fig. 4 shows another combination. Supposing it is wished to flange a turned plate, such as a dome end, or to flange a front end plate to receive the furnace tubes, this is done as follows: The two vertical hydraulic rams, C and D, are coupled together (see Fig. 2), the upper block or flanging die serving as the crosshead, the lower block or matrix, N, is placed on the bedplate, B, and the flanging is done in the usual way.

It will be observed that this system not only effects an immense saving in the cost of blocks and dies for very large or irregular work, but for this class of flanging it avoids the present outlay for a large heating furnace. The machine itself also is much cheaper, the cylinders of course being smaller owing to the work being done by several efforts instead of in one. The actual results, so far as the quality of the



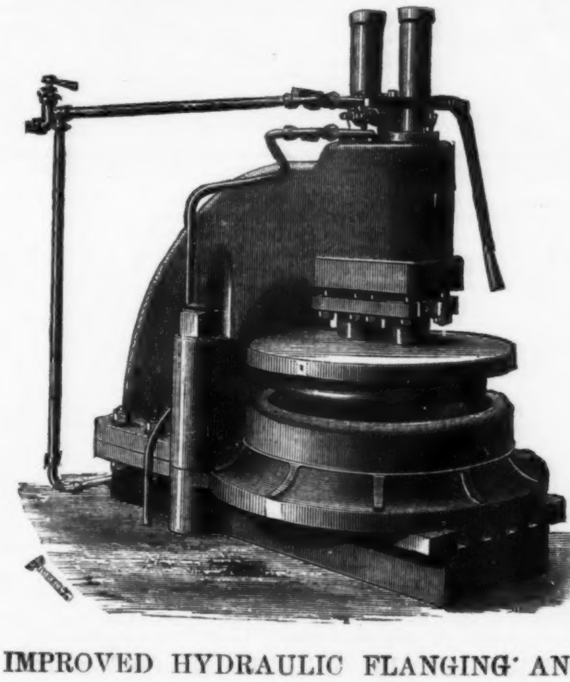


Fig. 3.

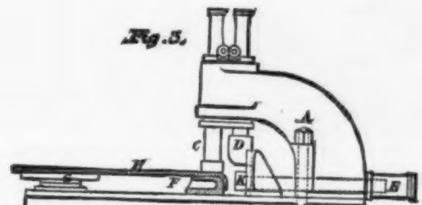
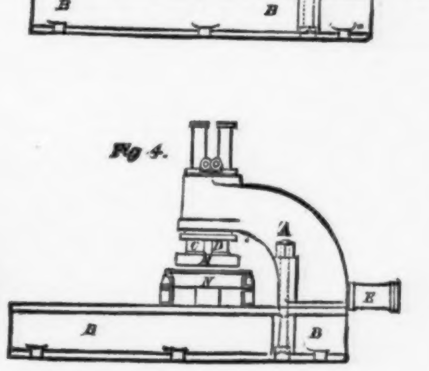


Fig 4.



IMPROVED HYDRAULIC FLANGING AND STRAIGHTENING MACHINE.

work is concerned, are excellent, and the economical results are also most satisfactory.

To a certain extent the machine at present is not favorably placed for economical working, and it will shortly be removed into the new boiler shop of the Wallsend Slipway Company; but the results up to now are, that it can do a given quantity of work in less than half the time, and at half the cost of the same, when done by hand. The quality of the work, moreover, is much superior to handwork, and there is a great saving in fitting and putting the boilers together.

The machine is very complete and well arranged, and is creditable to the manufacturers, Messrs. Fielding & Platt, of Gloucester, who, with Mr. Boyd, are co-patentees with Mr. Tweddell, to whose well-known system this is a most valuable addition.—*Engineering.*

THE WELLAND CANAL.

The enlarged ship canal to overcome the Falls of Niagara, constructed by the Dominion of Canada at a cost of nearly $12,000,000, is so far completed that it will be in operation before the end of the present month. Lake Ontario is the smallest and the lowest of the five great Canadian lakes, connected by the St. Lawrence River with the ocean at Montreal, but it is 190 miles long, 52 miles wide, and has an area of 6,700 square miles. Its south shore is the northern boundary of the State of New York, while Canada extends along its northern side and wraps round its western coast line. The lake is 234 ft. above the Atlantic, and Kingston, its eastern extremity, where the St. Lawrence commences, is 1,164 miles from the mouth of that river at the Straits of Belle Isle. Of this descent, 206½ ft. are overcome by means of six canals, all constructed by the Canadian Government, in the following order from Montreal upward:

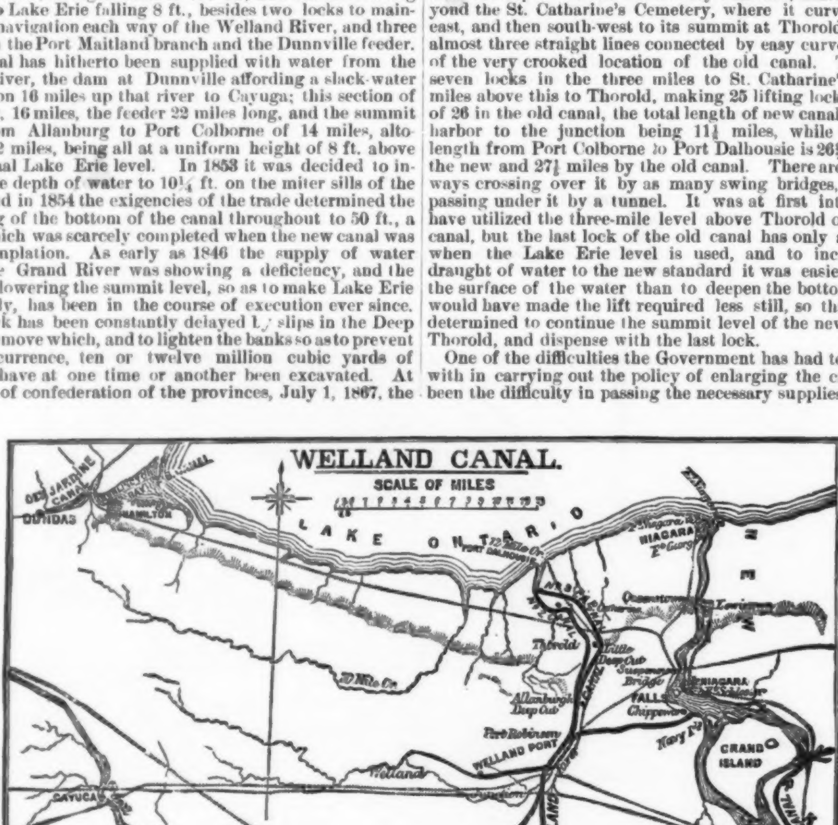
					ft.
Lachine	8½	miles long,	5	locks rising	44¾
Beauharnois	11¼	"	9	"	82½
Cornwall	11½	"	7	"	48
Farran's Point	0¾	"	1	"	4
Rapide Plat	4	"	2	"	11½
Galops	7⅝	"	3	"	15¾
	43⅝		27		206½

The total fall of the river from the lake to Montreal Harbor is 221¾ ft., the remaining 15¼ ft. spread over 184 miles being imperceptible. Montreal itself, to which the largest ocean steamers now ascend, is 86 miles from tide water and 12¼ ft. in height above it. Port Dalhousie, the lower end of the Welland Canal, is therefore 234 ft. above the tide, and 1,334 miles from the outlet of the St. Lawrence.

Lake Erie, the second in ascending order of the Great Lakes, is 250 miles long, 60 miles wide, and covers over 10,000 square miles in area. It is 564 ft. above the tide level, and 330 ft. above Lake Ontario. Its outlet is the river Niagara, only 30 miles long, and all but 14 ft. of the total descent is accounted for by the great cataract, and the rapids above and below it, concentrated in the 10 miles of its length between Chippewa and Queenstown. Above Port Colborne, the upper terminus of the Welland Canal, for 1,000 miles to Chicago, at the head of Lake Michigan, there is no lock nor any obstruction to a vessel drawing 16 ft. of water; Chicago or Milwaukee being only 16 ft. above Port Colborne, while the immense inland sea of Superior is only 22 ft. above Lake Huron, the third of the series, the ascent from which is accomplished by one immense lock, and the short Ste. Marie Canal on the American side of the Strait. From Fond du Lac, at the head of Lake Superior, is 2,384 miles from the mouth of the St. Lawrence, while Liverpool is 2,234 miles from the same point. Half way along this immense inland navigation, the Welland Canal overcomes 330 ft. descent of the 600 ft. that Fond du Lac is in altitude above Liverpool.

The Niagara descent has, therefore, always been the formidable point in any scheme for the navigation of these waters, and the Welland Canal is the important link that makes the whole possible. No sooner was the war of 1814 over, and Canada was a reality, than the idea of making a canal between the two lakes took practical form. In 1817 the Honorable W. H. Merritt published a pamphlet on the subject, advocating the construction of a canal from the mouth of the Twelve Mile Creek, the present Port Dalhousie, to the Welland River, about 16 miles in length. The Welland River is a wide navigable stream parallel to and intermediate between the two lakes, with little current in its lower reaches, and it runs into the Niagara River at Chippewa above the rapids, from which point the Niagara is navigable for ordinary sailing vessels to Lake Erie. On the 19th of May, 1824, the same year that the Erie Canal was opened through from New York to the foot of Lake Erie, the Welland Canal Company was incorporated, and on the 30th of November of that year, seven years and one day after Mr. Merritt's pamphlet was published, work was actually commenced. By 1828 the construction was so far advanced that the day was fixed for the opening, the difficulty being then as it has been throughout, the cutting through the heavy ridge, the watershed between the Welland river and the Niagara escarpment, the "Allanburg Deep Cut." Mr. Merritt's idea was to use the water of the Welland River as a feeder to his canal. At the point where the canal commenced the Welland is 9 ft. below the level of Lake Erie, the Niagara having a strong current immediately after leaving the lake, and the Welland being practically on a level with it below this rapid. To utilize the Welland, therefore, as a feeder, required a cutting through the Allanburg Ridge of about 60 ft. for nearly two miles. Just before the intended opening this heavy cutting slipped in and gave the last blow to the tottering credit of the Canal Company. The whole plan was now necessarily changed. The Welland River was abandoned as a feeder, the level of the canal was raised 17 ft. through the Deep Cut, a lateral excavation was made 22 miles long to the Grand River, at Dunnville, where a dam raised the water to a height of 8 ft. over the Lake Erie level, and two locks made the connection with the Welland River, descending 17 ft. from the canal. Five years after the commencement of the works to a day, on the 30th of November, 1829, two vessels, one British and one American, climbed up the thirty-seven wooden locks to the summit level; descended the two locks into the Welland River at Port Robinson, 16½ miles from the entrance on Lake Ontario, passed 9½ miles down the Welland River, and sailed up the Niagara to Lake Erie. A subsequent improvement enlarged five miles of the "feeder," including a substantial aqueduct over the Welland River, and extended the canal 6½ miles to Port Colborne on Lake Erie, where a single lock with a descent of 8 ft. lowered a vessel into that lake. This was completed in 1833, and formed the first Welland Canal; the locks were 110 ft. long by 22 ft. wide, and vessels drawing 7½ ft. could pass through it. The construction of this work, begun when Upper Canada had scarcely 100,000 people, sparsely scattered over an immense area, is a wonderful instance of persevering energy surrounded by the most unfavorable circumstances.

In 1839 an act of Parliament authorized the purchasing of all the stock held by private individuals with a view to taking over the canal as a public work; but this was not carried out till after the union of the province in 1841, when the total outlay, including Government grants of all kinds, amounting to $2,073,647. The next year the present Welland Canal, No. 2 we may call it, was commenced, permanent stone locks taking the place of the old wooden ones, and their size increased to 150 ft. in length by 26½ ft. wide, with 9 ft. of water on the sills. By 1845 the main line was complete from Port Dalhousie to the junction of the old feeder, and this had been converted into a canal of the same dimensions, entering the Upper Lake at Port Maitland, the only natural harbor on the Canadian shore of Lake Erie. The Port Colborne Extension, with enlarged entrance locks at both the north and south ends of the canal, 200 ft. long by 45 ft. wide, was completed by 1848, but the canal, as since working, was not altogether finished before 1850. There was then, as there are now, twenty-six lifting locks from Lake Ontario, rising a total of 338 ft., and one descending lock into Lake Erie falling 8 ft., besides two locks to maintain the navigation each way of the Welland River, and three others in the Port Maitland branch and the Dunnville feeder. The canal has hitherto been supplied with water from the Grand River, the dam at Dunnville affording a slack-water navigation 16 miles up that river to Cayuga; this section of the river, 16 miles, the feeder 22 miles long, and the summit level from Allanburg to Port Colborne of 14 miles, altogether 52 miles, being all at a uniform height of 8 ft. above the normal Lake Erie level. In 1853 it was decided to increase the depth of water to 10¼ ft. on the miter sills of the locks, and in 1854 the exigencies of the trade determined the widening of the bottom of the canal throughout to 50 ft., a work which was scarcely completed when the new canal was in contemplation. As early as 1846 the supply of water from the Grand River was showing a deficiency, and the work of lowering the summit level, so as to make Lake Erie the supply, has been in the course of execution ever since. This work has been constantly delayed by slips in the Deep Cut, to remove which, and to lighten the banks so as to prevent their recurrence, ten or twelve million cubic yards of material have at one time or another been excavated. At the date of confederation of the provinces, July 1, 1867, the canal was capable of passing a 400 ton steamer, and its construction had involved altogether an outlay of $7,638,239.



In November, 1870, the question of enlarging this and the other St. Lawrence canals was taken up by the Government, and a new canal was decided upon to have locks 270 ft. long by 45 ft. wide, with a depth of 14 ft. of water upon the sills, the canal between the locks having a prism of 100 ft. wide at the bottom with 15 ft. depth of water, and it is this work, the third Welland Canal, that is now about to be thrown open to traffic. On the 29th of April, 1872, the chief engineer, John Page, presented his report as to the best means of carrying out the work, and after the most exhaustive surveys he decided to make a new canal altogether for the Ontario section to the summit level, and thence to deepen and widen the old canal to Lake Erie. It is not doubted that the old canal occupies the best route that can be found between the two lakes, and that the terminal harbors are the best points that can be selected for the purpose, but there were insuperable difficulties against enlarging the existing locks, while the marvelous development of the country and expansion of the trade made it imperative that the working of the canal should not be interfered with. It is not so much the actual elevation to be overcome, as the short distance in which this had to be done. The brow of "the mountain" at Thorold is only six miles from Lake Ontario. On the old canal a dam and lock at the outlet of the Twelve Mile Creek had converted into a deep water basin a considerable area, the level of which extends 3½ miles to St. Catharine's. The line follows the valley of the creek above this to the tenth lock, where the bottom of the lock is about level with the natural surface. Above this to the twenty first lock the canal follows a line parallel to the northern face of the high ground, the distance from the head of one lock to that of another varying from 586 ft. to 800 ft.; the twenty-fifth lock being nine miles by the canal from its northern outlet on the lake, and 323 ft. above it. This level continues for 3¼ miles to Allanburg, where the summit level is reached by a lock lifting 15 ft. when the Grand River level is used, and 7 ft. when the Lake Erie level is the source of supply. It was determined when the new canal was designed that the distance from the head of one lock to the head of the next should not be less than 1,000 ft., so that two vessels may lie in each reach between the locks without interfering with a passing craft, a desideratum that could not be arranged on the old location.

Another difficulty to be encountered was the crossing of the railways. Since the opening of the canal four main lines of railway had been constructed over it, all having drawbridges, while another had been built closely parallel to the canal between the same termini, and near to its eastern bank. The only possible alternative route required to cross this twice, a good line being discovered to the east of this railway, or rather adopting its location for some distance, and making a new railway still to the east of the canal. This again interfered with the level of the Great Western Railway from Hamilton to Suspension Bridge, to obviate which it was ultimately determined to construct a tunnel underneath the canal through which the Great Western Railway now passes. The new canal, therefore, commences in the harbor of the Twelve Mile Creek about half a mile from Lake Ontario, the entrance lock being to the eastward of the old lock, and opening into the basement of the old canal, which has been deepened to 17 ft. and enlarged to an area of 16 acres, giving shelter, if necessary, to 150 vessels. This lock is a massive affair, with its waste weir at the side, and like all the rest is 270 ft. clear in the chamber and 45 ft. between the gates, the depth of water on the sills being 14 ft. All the locks are of the same dimensions, built of the excellent stone of the neighborhood, the hard Magara limestone, which can be procured of any dimensions, the whole being laid in Thorold cement. From this the canal follows a lateral depression known as May's Ravine, nearly east beyond the St. Catharine's Cemetery, where it curves south-east, and then south-west to its summit at Thorold, making almost three straight lines connected by easy curves instead of the very crooked location of the old canal. There are seven locks in the three miles to St. Catharine's, and 18 miles above this to Thorold, making 25 lifting locks instead of 26 in the old canal, the total length of new canal from the harbor to the junction being 11¼ miles, while the total length from Port Colborne to Port Dalhousie is 26¾ miles by the new and 27½ miles by the old canal. There are five railways crossing over it by as many swing bridges, and one passing under it by a tunnel. It was at first intended to have utilized the three-mile level above Thorold of the old canal, but the last lock of the old canal has only a 7 ft. lift when the Lake Erie level is used, and to increase the draught of water to the new standard it was easier to raise the surface of the water than to deepen the bottom, which would have made the lift required less still, so that it was determined to continue the summit level of the new canal to Thorold, and dispense with the last lock.

One of the difficulties the Government has had to contend with in carrying out the policy of enlarging the canals has been the difficulty in passing the necessary supplies, in view of the fact that railways have been latterly successfully competing with the canals for the carrying of even the heaviest and coarsest produce, and that while the canals, with their tolls cut down to a non-supporting traffic, were not attracting additional traffic, the railways were possibly not yet down to the lowest point at which they could continue the competition. The Erie Canal and the New York Central Railway, with both of which the Canadian canals are competitive, were cited as an illustration. Both start alike at Buffalo and end at New York; both connect Lake Erie and the Upper Lakes with the ocean. The canal had first given the impulse to the settlement of all this new wheat district, and for years enjoyed all the traffic; gradually one item after another has disappeared from the freight list of the canal, and now all that remains for it to carry are cereals, lumber, coal, and the coarser class of foods, for which during the late depression the railway was contesting so closely that, excepting by an abrogation of nearly all the tolls on the canals, the boatmen and carriers were unable to make a living. In 1879 wheat was carried from Buffalo to New York, 450 miles, for 3¾ cents, and corn for 3¼ cents a bushel, the lowest it had ever touched. At the same time steamers on the Upper Lakes were carrying wheat the long detour from Chicago to Buffalo, 1,000 miles, for 2 cents per bushel, one-twenty-seventh of a penny per ton per mile, and corn was carried for even less. The whole service, including transshipment at Buffalo, was done for a trifle over 6 cents, or 3d. per bushel for wheat, and less than 3d. for corn, and even at these rates the canal carriers were not clear from railway rivalry. As low rates became the rule, it was only the extreme economy of the large vessels on the lakes that enabled the canal to live at all. Apart from the through business, and the working together of the lake and canal interests, the Erie Canal for freight originating in Buffalo had a poor chance. From this it follows that the greater distance done by the large vessels on the lakes, and the less mileage worked by the canals, the cheaper will be the total cost, and hence with the enlarged Welland Canal, Oswego, at the foot of Lake Ontario, will take the place in the future of Buffalo on Lake Erie, for the American canal-borne traffic, as saving 100 miles of canal, and using instead the cheaper navigation of the lake. This substitution of one American port for another, although admitted as being of some benefit to the Canadian canal system, was not of sufficient importance to justify the outlay necessary for the enlarged Welland Canal. The great argument lay in the total cost from the large collecting centers, Chicago and Milwaukee on Lake Michigan, Duluth and Fort William on Lake Superior, to the Atlantic

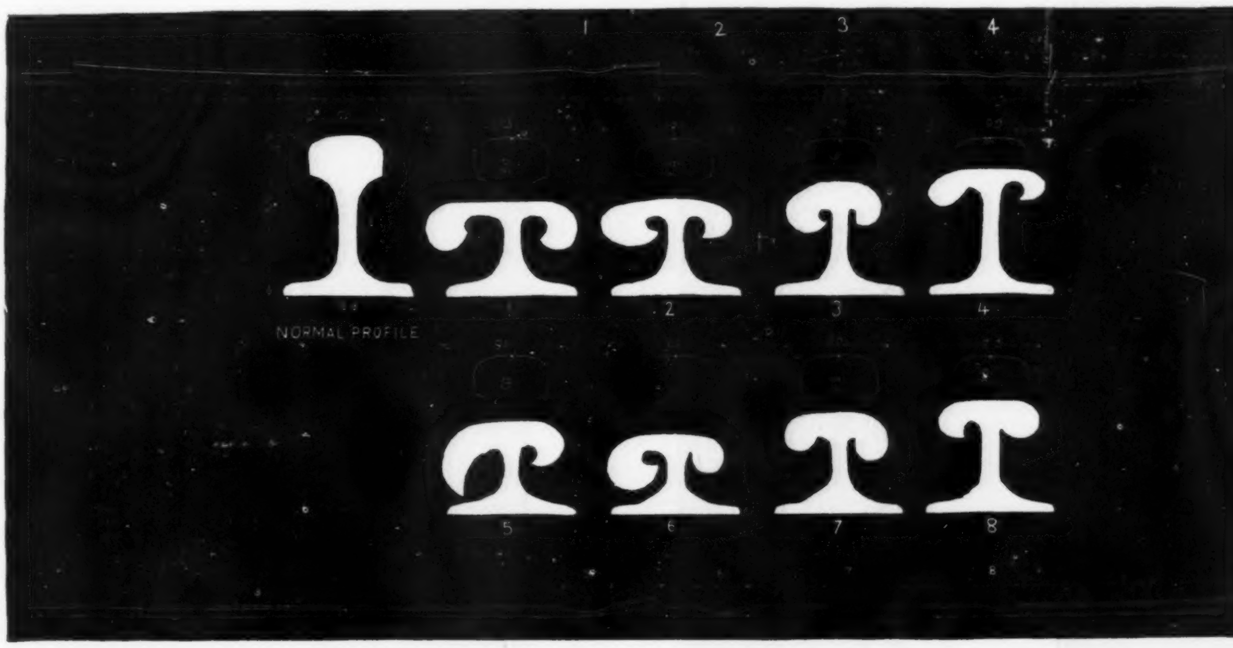
ports of Canada and the United States respectively. There is no more natural difficulty in cutting another Welland Canal on the American side of Niagara than there is in making it through Canada, but it has been the policy of the State of New York to prevent, as far as possible, Western produce from ever reaching the low level of Lake Ontario. The originators of the Erie Canal constantly affirmed that Western trade once on the St. Lawrence level would follow its channel to the seaboard, and the rare foresight which carried their own great work for so many miles parallel to the Lake Shore, and 200 ft. above it, and kept this enormous traffic beyond the attraction of the natural river navigation, is seen to-day in the vast business that crowds the wharves of Boston and New York, and which is seriously imperiled by the new Canadian canals.

The Erie Canal, from the foot of the upper lakes, is 352 miles in length, the combined length of the Canadian canals for 2 400 miles from the head of Lake Superior to Belle Isle, is only 72 miles, and using the same factors in the calculation, the grain that cannot profitably be transported for less than 8½ cents to New York from the great wheatfields of the West, can be taken to the ocean steamer in the St. Lawrence, 300 miles nearer to Liverpool than the American port, for 5 cents a bushel. A saving of 3½ cents, or 1¾d., may seem at first sight a small matter for two great peoples to put forth their utmost energies to secure, but it means £4,000 000 saved in moving last year's wheat crop alone, and it involves the carriage of 5,000,000 tons of cereals taken last year to the seaboard for foreign exportation. The present figures are easily calculated; what they may amount to in the future it is impossible to tell. The Census Bureau at Washington reports the increase in the production of all kinds of grain during the last ten years at 100 per cent. Some descriptions show more than this; the increase in corn was 133 per cent., and the three Western States of Illinois, Iowa, and Missouri produced more in 1879 than the entire country did ten years before. Of the whole national supply of 1868 only 3 per cent. was exported, in 1878 10 per cent. of the doubled yield was sent abroad, and last year 12 per cent. of the still larger harvest, in all 246,000,000 bushels of every description of cereals, were exported. The saving of a cent or two a bushel is therefore of vast import. It can also be done by the Canadian route in four days less time. The present barges on the Erie Canal carry 7,000 bushels of wheat or other grain, and can only be used on the canal and the Hudson River, involving a transshipment at Buffalo, which is generally an expense of a cent a bushel, although only estimated in the above figures at half this, which it is believed it may be done for with better arrangements. The present schooners working through the Welland Canal carry 20,000 to 22,000 bushels, and have no transshipment; but these vessels are too small for economical work on the lakes, cannot compete with the 60,000 or 70,000 bushel craft in use between Chicago and Buffalo, and cannot find profitable employment excepting when the canal has to be passed to the Lower Lake. The new canals will admit the most economically sized vessels now afloat on the lakes to pass through the locks, and it is still a question whether the very large vessels lately put afloat, and which are too large for the new Welland, can work any more economically than those which are somewhat smaller. An iron or steel vessel, 250 ft. long, 38 ft. beam, and 22 ft. depth of hold, is as large as can be comfortably handled in most of the lake harbors, and when drawing 14 ft. water is large enough to be safely navigated over the St. Clair Flats or in the Neebish Rapids. She would carry 80,000 bushels, and with one or two towing consorts, could carry grain to Quebec for 5 cents per bushel, and pay a better interest on the money, than the present American craft earning 15 cents per bushel from Chicago to the ocean, but transshipping into the canal at Buffalo. This class of vessel can work at such a price that neither the railways nor the Erie Canal can begin to compete, and therefore our people argue that when the other canals are equal in capacity to the Welland and the Lachine, both of which are now of the same size, all the Western trade must come through Canadian waters. Last year the old Welland carried 14,000,000 bushels of grain all told, the new canal could pass that quantity with equal facility in a week; so that if all of them were of the enlarged type the Canadian canals could handle all the grain now being exported, or likely to be for some time, from the Western States and the North-west Provinces.

Enlarging the size of the vessels employed in this carrying trade, at all events to the capacity of the present average, has had a direct influence in reducing the rates. When the present Welland Canal was built it would take the largest vessels, from 400 to 430 tons, then working between Buffalo and Chicago. Last year the average of the vessels chartered between these two points was 1,000 tons, and five of them measured over 1,700 tons each. In 1861, when the Welland size was the largest in use, the freight ruled 11 cents per bushel. In 1873, when towing consorts the same size as the steamer were introduced, 7 cents was the average; now with large vessels of both kinds 3 cents is the general figure from Chicago to the lower end of Lake Erie. For the last three years vessels have been building of sizes from 2,000 to 2,500 tons, for the lake trade, and last year one company set afloat six pairs of vessels, that is, six steamers, and six consorts of the same size without engines, each of 2,000 tons carrying capacity. This season a five-masted schooner has made its appearance, to carry 100,000 bushels, nearly 3,000 tons. A recent number of the Chicago *Inter-Ocean* gives a list of over 50 vessels now on the Upper Lakes of over 1,000 tons burden, fifteen of which are from 1,500 to 2,000 tons, and one 2,082 tons, and at the same time there were 40 vessels on the stocks, each of 2,000 tons or over, some of them from 2,500 to 2,800 tons. At the beginning of 1881 the total registered vessels on the lakes were 3,147 in number and 614,377 in tonnage. The Canadian lake marine, on the contrary, for some years has been declining, and at the same date the total number of vessels was only 1,587, and the burden 212,138 tons, the American coasting laws bearing very heavily against this description of property.

There is another economy that the enlarged canals will bring about. While the present canals will not admit vessels that can be economically used at sea the new dimensions will do so. For half the year the St. Lawrence is closed with ice. The new canals will enable suitable vessels to escape from the lakes before the winter sets in, and get down the St. Lawrence to the open sea to make a voyage to the West Indies or even to Europe, and so utilize the winter months. The vessel referred to above may work in the lake trade with her consorts, bringing from 150,000 to 200,000 bushels of grain to Quebec each trip, where leaving her consorts for the winter she may find employment in the tropics, and be back in the spring. When working with her consorts on the lakes she would draw from 13 ft. to 14 ft. of water to suit the canals, and from 15 ft. to 17 ft. when in salt water, and be a serviceable vessel either above or below Quebec the year round.

Much, however, remains to be done before this can be realized. The enlarged Lachine or the enlarged Welland is but of little service as long as the Beauharnais and the Cornwall Canal have only 9 ft. of water. But Canada has reason to be proud of the two that are complete; and it is to be hoped that nothing may be allowed to retard the work on the others still to be enlarged and improved.



CURIOUS WEAR OF RAILS.

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AN Austrian engineer writes: "While in Milan a short time ago, I observed some steel rails covered with rust lying in a corner of the court of the Ecole Polytechnique. Their abnormal appearance excited my curiosity so much that I determined to make a sketch of them and to find out the cause of their deformity. They were placed in the tunnel of Pitecchio, on the line from Bologna to Pistoia. The misshapes were caused as follows: On the night of December 9, 1878, the ordinary train left Pitecchio at 2:24. It was composed of 15 wagons, and the gross weight was 142 tons. After leaving Pitecchio, the train only traversed 1,660 meters, with a grade of 0·023 meter, and on a curve and counter curve of 300 meters radius; 1,450 meters of this lay in the tunnel. But the train had scarcely entered the tunnel when the locomotive could make headway only with difficulty owing to a coating of ice on the rails; and the force of adherence between the wheels and the rails became so small that 307 meters from the northern opening of the tunnel, the machine, although continuing to work, failed to make any headway. The conductor of the train, who was in the baggage compartment, could not at first make out the cause of the stoppage, but on taking up a lantern and looking at the walls of the tunnel he found that the train was at a standstill. After vainly signaling to the engineer, he went forward to the locomotive, where he found both the engineer and fireman lying unconscious from the effects of the accumulated steam. A heavy storm of wind and snow was blowing. Another train had passed over the same rails, but from the contrary direction, and had rendered their surface as slippery as ice; this surface was owing, of course, to the steam and smoke which condensed in the tunnel. Sand was thrown on the rails, but to no effect. At 4:20 A.M., an engine arrived, but it required a third locomotive to move the train. The driving wheels of the locomotive produced the misshapes during this stopping time. There were only two ruptures, but on the other hand, the rails were laminated and twisted by the rupture of the fish-plates. It is to be regretted that no further information could be obtained, as it would extend our knowledge of the resistance of steel rails." The accompanying cut shows the curious manner in which the rails were beaten down at the points indicated.—*Railway Review.*

EXPRESS AND BULLION SAFES.

To the Editor of the Scientific American:

Observing your remarks in the SCIENTIFIC AMERICAN of the 13th August and its following number, it occurs to me that something further may be said concerning the past and present efforts which have been made to protect property in express and bullion safes.

In 1873, the writer visited England, Ireland, Scotland, France, Austria, Prussia, and Belgium, making a thorough study of their locks and safes, and found, in a general sense, the English had appropriated the old Chinese idea of putting two or more locks upon each door of their secure receptacles, giving a key to different persons so as to prevent opening until all were present.

The English, however, improved upon the Chinese plan by using only one lock requiring several keys in the hands of different persons to accomplish unlocking, and although many other kinds of locks were in use, yet that of the multiplied key system was regarded as affording the most protection.

Over the European continent, except in France, and to some extent even there, I found the English locks had found a market and the most favorable reception and highest reputation.

American combination locks have never been used to any extent in Europe, mostly because it was only necessary to capture the person who held the combination of them, when an entrance was easily effected by compelling such person to unlock the safe. Such locks were regarded as a constant danger swung over the heads of all who held their combinations, and the English confidently asserted the superiority of their own multiplied key system of combination locks over our American locks.

The numerous express and train robberies, as well as those of the banks and business men of our country, prove that the English were right; and while many people account for such robberies and their fewness in the old country by asserting that the latter is protected by a better police force than in America, it is nevertheless a mistake, not that the foreign police is less extended, but that the robberies there are less than here because of any superior efficiency of their police.

In my opinion the cause of our frequent robberies is the knowledge of the robbers that express and bullion safes and many bank safes can be robbed simply by discovering and capturing him who holds the lock combinations; and the English are fewer because such an act cannot be done with their locks so quietly and effectively as under our American system.

There is danger under our old system because of the constant temptation held out to every man who is weak enough to yield to his necessities or to his love of gold.

One of Herring & Co.'s (safe and lock manufacturers) salesmen fell a prey to his knowledge that the possession of the combinations would make him rich and he became a willing participant in one of the greatest robberies of this age.

Out of this condition of things sprang some if not the very greatest of inventions in the art of lockmaking since the world began; and America to-day has not only fully overcome all the above defects and objections to her bank and safe locks, but she now leads all countries, even in the very line we refer to where the English were once foremost.

To-day there are American combination locks which are unpickable; having no inconvenient keys to carry; requiring six persons, if desired, to be present to unlock them; possessing the capacity to have the labor of unlocking them diminished five-sixths through the day of what the night guard requires; susceptible of being changed from what is known as a six-tumbler lock to a one-tumbler or more as quickly, easily, and rapidly as opening a knife blade; suitable to apply to the smallest or largest receptacles; having such simplicity of operation that anybody may handle them; capable of use on express safes, so no route agent nor any station agent can unlock them until they get a telegram informing them how, and these cannot repeat unlocking after closing until reinforced how to do so.

But a greater American achievement is our time locks,

which are yet more powerful and, indeed quite wonderful, since they can perform all that a combination lock can of the designated kind, and do many additional acts which make them appear to be almost a living thing.

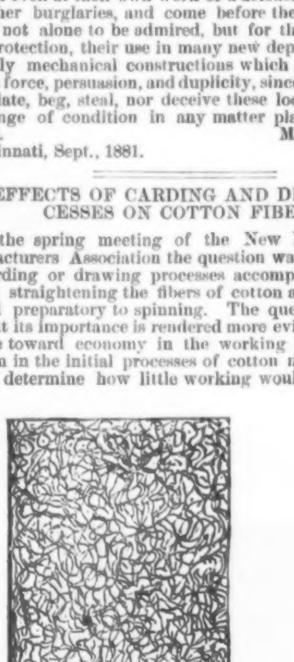
These beautiful constructions always remain true to their trust, their motion being their life, as it were, which regularly hands over their charge at the appointed hour; but should their motion stop, leaving them still as death, they will yet put themselves in a condition which surrenders to none but their owners, an almost human discrimination and ranking them among the most useful and singular of man's inventions.

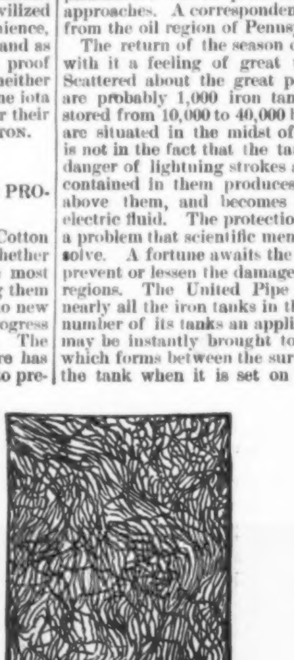
These modern American devices have far eclipsed the English even at their own work of a defense against masked and other burglaries, and come before the whole civilized world, not alone to be admired, but for their convenience, their protection, their use in many new departments, and as the only mechanical constructions which are alike proof against force, persuasion, and duplicity, since you can neither intimidate, beg, steal, nor deceive these locks into one iota of change of condition in any matter placed under their control. M. A. DALTON.

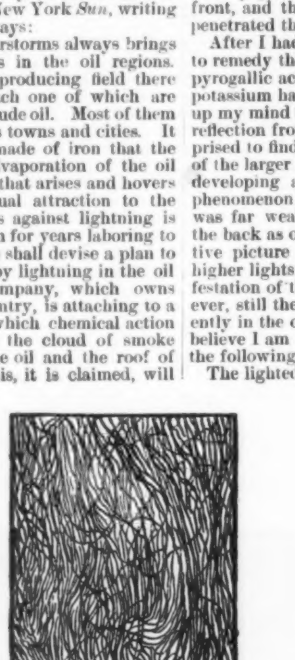
Cincinnati, Sept., 1881.

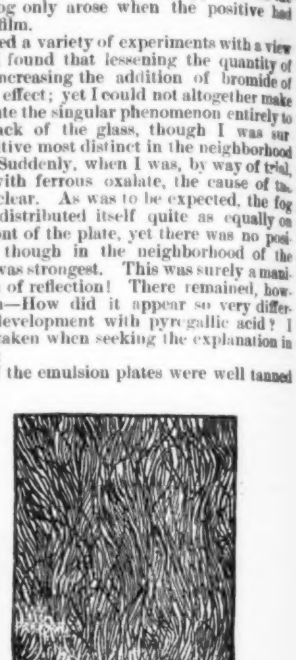
THE EFFECTS OF CARDING AND DRAWING PROCESSES ON COTTON FIBERS.

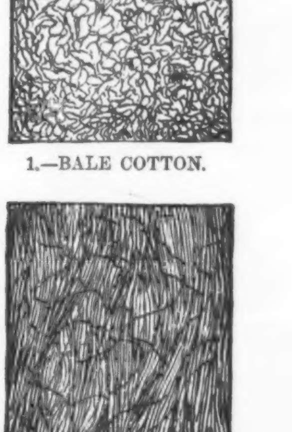
AT the spring meeting of the New England Cotton Manufacturers Association the question was raised whether the carding or drawing processes accomplished the most toward straightening the fibers of cotton and laying them parallel preparatory to spinning. The question is no new one, but its importance is rendered more evident as progress is made toward economy in the working of cotton. The problem in the initial processes of cotton manufacture has been to determine how little working would suffice to prepare the fiber for spinning, and not how much manipulation would the staple stand. It is essential in the interest of profits from the saving of labor, time, and space, as well as to the end that the staple may sustain the least possible injury, that its manipulation be reduced to the least possible amount that will accomplish required results. As carding must of necessity be rather severe upon the delicate fiber, it is important to determine whether this process can be abbreviated and more work left to the drawing process. This must, of course, be considered independent of the cleaning of cotton. When the staple is required to be clean for fine work, carding or combing are the necessary processes, but we are in the present instance considering carding only with reference to the work it performs in strengthening fibers. The more modern forms of cards undoubtedly tend to accomplish the work which devolves upon the carding machine at a considerable saving of wear upon the stock. The extent to which the wear can be further reduced has not yet been demonstrated. At the meeting of the Cotton Manufacturers Association last October, Mr. F. A. Leigh stated that some years ago he had conducted a series of experiments in carding by reducing the number of flats, and he obtained as good carding with four flats as with twenty. This statement is significant of what changes may yet occur in the preparatory processes of this staple, though it implies a more radical departure from existing methods than any one would at present care to predict. With a view to possibly throwing some light upon the respective functions of the carding and drawing machines, we obtained through the courtesy of Mr. Joseph Dronsfield, of the Fletcher Manufacturing Co., Providence, R. I., samples of cotton from the bale, and after each succeeding stage in its manufacture up to and including the third drawing. In handling the samples great care has been taken to not disturb the fibers, and the accompanying cuts represent the direction of the fibers exactly as they appear immediately after each of the operations named. The engravings show as clearly as possible the surface appearance of the lap or sliver examined with a lens through an oblong aperture one-quarter the size of these illustrations. How much of the work now applied to the stock between the lapper and the railway head could be omitted, it would be difficult to say from the showing made by these examinations.—*Manufacturers' Review.*

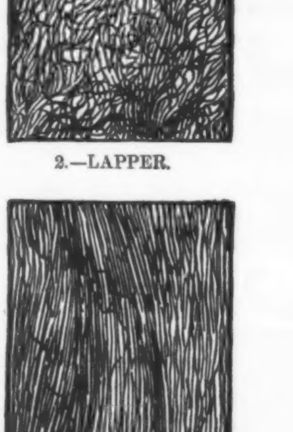

1.—BALE COTTON.

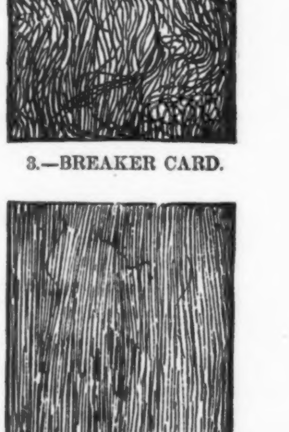

2.—LAPPER.

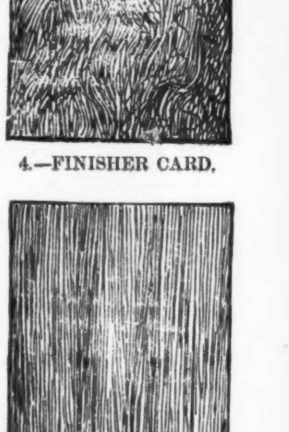

3.—BREAKER CARD.


4.—FINISHER CARD.


5.—RAILWAY HEAD.


6.—FIRST DRAWING.


7.—SECOND DRAWING.


8.—THIRD DRAWING.

PETROLEUM AND LIGHTNING.

PETROLEUM and lightning have an affinity which is not pleasant for the oil producer to contemplate as the summer approaches. A correspondent of the New York *Sun*, writing from the oil region of Pennsylvania, says:

The return of the season of thunderstorms always brings with it a feeling of great uneasiness in the oil regions. Scattered about the great petroleum-producing field there are probably 1,000 iron tanks, in each one of which are stored from 10,000 to 40,000 bbls. of crude oil. Most of them are situated in the midst of populous towns and cities. It is not in the fact that the tanks are made of iron that the danger of lightning strokes arises. Evaporation of the oil contained in them produces a vapor that arises and hovers above them, and becomes a perpetual attraction to the electric fluid. The protection of tanks against lightning is a problem that scientific men have been for years laboring to solve. A fortune awaits the man who shall devise a plan to prevent or lessen the damage caused by lightning in the oil regions. The United Pipe Line Company, which owns nearly all the iron tanks in the oil country, is attaching to a number of its tanks an appliance by which chemical action may be instantly brought to bear on the cloud of smoke which forms between the surface of the oil and the roof of the tank when it is set on fire. This, it is claimed, will render the presence of flame impossible and will lessen the number of oil fires. No demonstration of the value of the extinguisher has been made, but if its action is satisfactory, it will be a god-send to the oil country.

The experiment of placing lightning rods about the tanks is being tried this year. One hundred and fifty men have been putting up rods, seventy feet above the tanks.

Besides the danger that threatens the oil regions every year from lightning, there are other sources from which destruction may be periodically expected. There are over 10,000 oil wells in the various districts. They are nearly all flowing wells, and are constantly pouring out streams of the most inflammable material. Pipe lines conduct the oil in all directions through the field. The ground, the buildings—highly combustible in themselves—trees, fences, and all the surroundings are entirely saturated with crude petroleum.

SOLARIZATION OF DRY PLATES.

SINCE gelatine plates have come into general use complaints have been and are always becoming more rife concerning solarization caused by bright surfaces surrounding them. Mr. Warnerke's interesting investigations have incontrovertibly shown that reflection from the back of the glass alone is blamable for this appearance. Yet there are some circumstances which seem to cast a doubt on the real nature of the phenomenon, so that it seems necessary to examine its cause and that of the accompanying circumstances a little more narrowly.

Some time ago it was remarked in this journal that a positive lies directly upon the glass under the developed negative. I must admit that until quite recently I have been a perfect stranger to such a phenomenon; but suddenly it appeared in some newly-prepared emulsion with such energy as to render the whole batch unusable. The circumstances were as follows: A sufficiently exposed plate was laid in the previously mixed pyrogallic acid developer (Nelson's sugar developer); the picture appeared wonderfully powerful and with great variety of tone. Suddenly a fog spread over all the deep shadows just as the last details were appearing, and the picture could not be prevented from becoming completely gray, by the most precipitate immersion in the washing water. On looking at the plate from the back its appearance was very surprising. The lights were not as yet to be seen, the highest only being indicated by faint traces; but a perfect, though very delicate, positive was visible. By further experiment it became manifest that the positive was already present before the first trace of fog appeared on the front, and that the fog only arose when the positive had penetrated the whole film.

After I had instituted a variety of experiments with a view to remedy the fault, I found that lessening the quantity of pyrogallic acid and increasing the addition of bromide of potassium had a good effect; yet I could not altogether make up my mind to attribute the singular phenomenon entirely to reflection from the back of the glass, though I was surprised to find the positive most distinct in the neighborhood of the larger lights. Suddenly, when I was, by way of trial, developing a plate with ferrous oxalate, the cause of the phenomenon became clear. As was to be expected, the fog was far weaker, but distributed itself quite as equally on the back as on the front of the plate, yet there was no positive picture present, though in the neighborhood of the higher lights the fog was strongest. This was surely a manifestation of the action of reflection! There remained, however, still the question—How did it appear so very differently in the case of development with pyrogallic acid? I believe I am not mistaken when seeking the explanation in the following manner:

The lighted parts of the emulsion plates were well tanned by the pyrogallic acid developer, and consequently absorbed little fluid. This action is, however, in the first instance, a superficial action. The extreme external part of the film having thus become difficult to penetrate, it is much longer before the underlying part of the film can absorb sufficient developer to effect the reduction of the lighted bromide of silver. In proportion, therefore, as the lighting is slighter, the developer penetrates more quickly. When an exposure from the back has taken place there begins the reduction of the bromide of silver, and in this way creates a positive, which, at the places almost unlighted from the front, develops forward before the developer has had time to penetrate down to the glass in the clearest lights. Of course this whole process is only possible when developing with pyrogallic acid—not with iron.

A very thick gelatine film is not a perfect protection against this appearance, because, in order to retain sufficient sensitiveness, it can scarcely be rendered so opaque as to prevent all reflection of the clear lights from the back. There is also the peculiarity of ripe emulsion transmitting blue actinic light. Still, backing the back of the glass plate with some substance which absorbs all the light that falls upon it should effect a relief. For that purpose the most suitable material seems to me to be collodion deeply tinted with a non-actinic aniline color. It is best to coat the plates with it *before* pouring on the emulsion, and of all the colors that might be used I recommend aurine.

The great advantage of this process, besides the decrease of solarization, is that this dry collodion skin dissolves off from the glass almost of itself, and that even when it still adheres it is so transparent as to allow the negative to be examined, during development, by transmitted light. The protection which it affords against reflection is very perfect; for, since the exponent of the refraction of the collodion differs but immaterially from that of glass, all the reflection

from the back of the glass is as good as removed, because all the light which falls down upon the back of the glass enters the collodion, while the light reflected from the external surface of the collodion has no actinic action, having passed twice through the stained film.

It might be asked here: How does it come that solarization occurs more seldom with ordinary wet plates? The reason is twofold: First, the sensitive film of the plate is only apparently a much better transmitter than that of emulsion plates. Actually the yellow color of the iodide of silver is very non-actinic, since, as is well known, a lantern can be used in the dark room when engaged in wet work with silvered and washed iodide-collodion plates. Then development appears with all wet plates as a superficial action, which hardly extends down to the very glass. If, therefore, the back of the film were to be lighted by reflection, the silver precipitate could only make its appearance if the light were strong enough to penetrate this second non-actinic film, which it very seldom is. In the case of emulsion plates, on the contrary, the picture penetrates the whole film so that development can very easily take place on the glass side, though the light which acts there is too weak to penetrate to the upper surface and effect the reduction of the bromide of silver there also.

Wherever there are strong contrasts of light and shade when working with emulsion, the photographer should, consequently, never neglect the precautionary measure of backing. The increase of expense and trouble involved is proportionately small, while the advantage of always obtaining clear and brilliant plates should be valued very highly.—*Franz Stolze, Ph.D., in British Journal of Photography.*

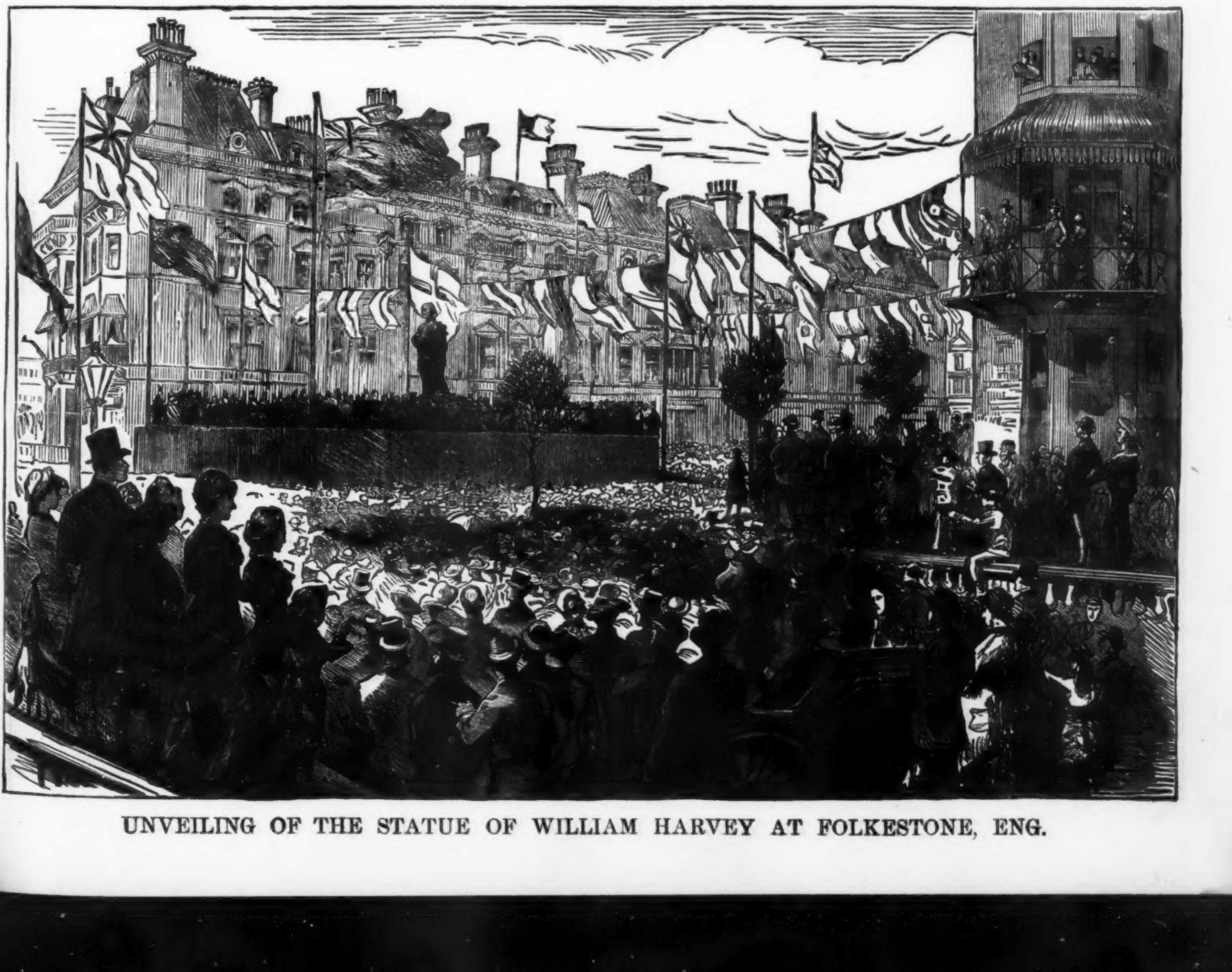
THE HARVEY STATUE.

A NUMEROUS company from London, including some of the professional and scientific men attending the International Medical Congress, went down to Folkestone on Saturday, August 6, 1881, for the ceremony of unveiling a statue of William Harvey, the discoverer of the circulation of the blood, who was born at that place in the year 1578. The tercentenary commemoration of his birth should have occurred three years ago, but it took the appropriate form of starting a subscription for erecting the statue of William Harvey, in pursuance of resolutions passed by a meeting over which the Mayor of Folkestone presided, Dr. George Eastes, a medical gentleman of that town, being the most active promoter of this undertaking. With regard to William Harvey's personal history, all that need here be recited was given in a lecture by Canon Jenkins, and in a paper read at the meeting above referred to by Mr. Eastes. It will save the necessity of further reference to subjoin the bare facts of Harvey's career:

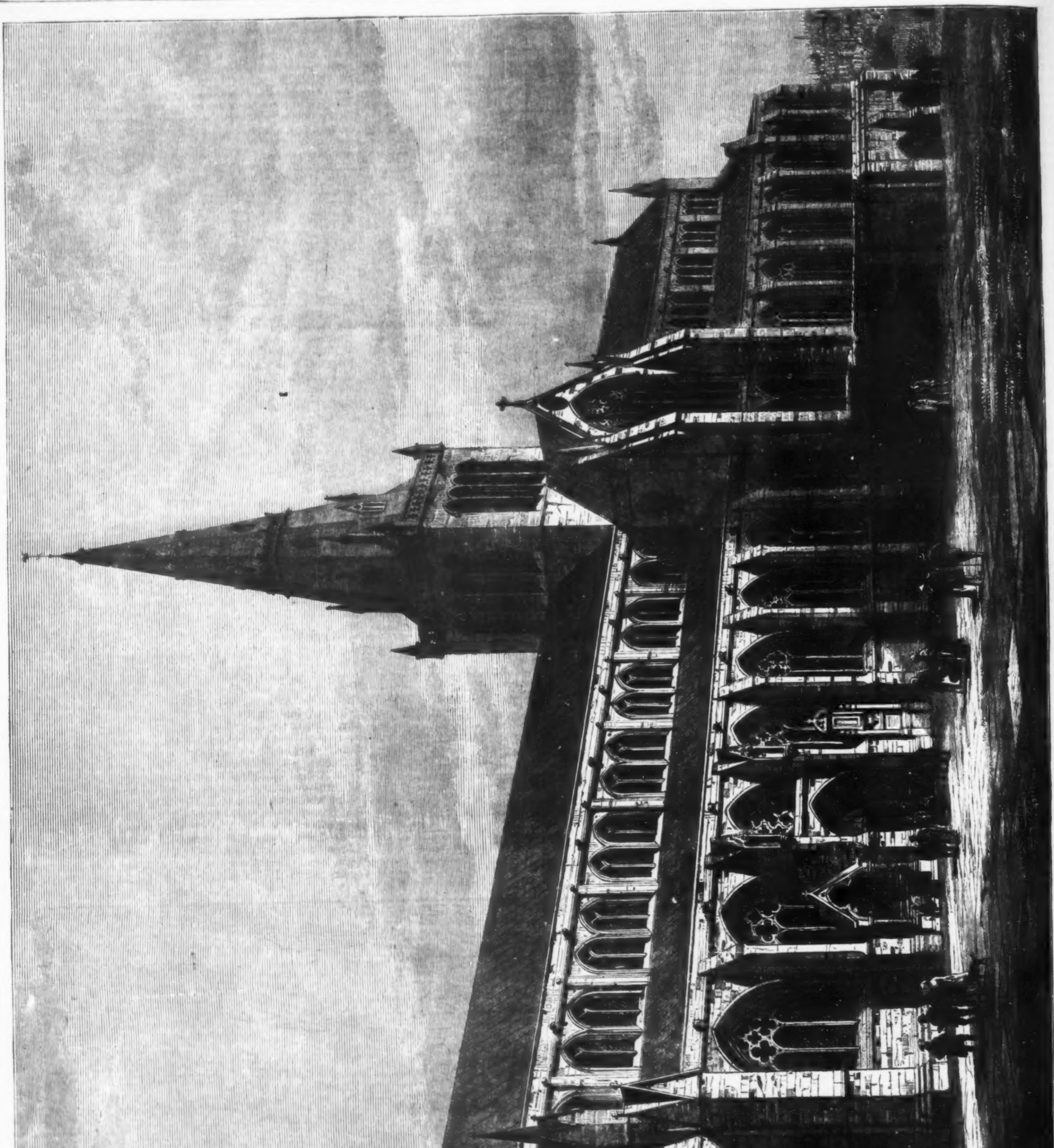
William Harvey was born in Folkestone, on April 1, in the year 1578. He was the eldest of nine children. A tradition exists in the town that the house in which he first saw the light was situate where Fellenberg House now stands. His father was a man of property, able to give his sons a good education and start them well in their vocations. Unfortunately, the parish register of births and marriages in Folkestone begins its record only in the year 1635, when Harvey was fifty-eight years old, so that it is silent concerning him. In 1588, at ten years of age, he was sent to the Grammar School of Canterbury, and remained there until May, 1593, when (as the register of his college testifies) he entered as a scholar at Caius College, Cambridge. After three years of University life he took his degree of B.A., and quitted Cambridge. There being no medical schools of repute of that day in England, Harvey repaired to Padua, which then numbered among its professors men of the very highest renown. He spent the next five years in Italy, then obtained his diploma as doctor of physic, and returned to England; received his doctor's degree from the University of Cambridge, went to London in his six-and-twentieth year, 1604, married, and entered on the practice of his profession. At the first vacancy he was appointed physician to St. Bartholomew's Hospital, and in his thirty-seventh year was chosen lecturer on anatomy at the College of Physicians. Early in the course of these lectures he presented a detailed exposition of his views concerning the circulation of the blood, which he repeated yearly, but which he did not publish to the world until 1628, when he was consequently fifty-one years of age. Then his celebrated treatise on the motion of the heart and blood first saw the light, and laid the foundation of modern medical science. Harvey by this time had been chosen Physician Extraordinary to King James I., and seems to have been now at the zenith of his reputation as a physician. But his professional prosperity was soon marred by his great discovery; after his book on the circulation of the blood came out he fell mightily in his practice; it was believed by the vulgar that he was crack-brained, and all the physicians were against him. Harvey's connection with the court occupied much of his time. He was sent abroad with the young Duke of Lennox in 1630; in 1633 he accompanied Charles I. to Scotland, and was absent almost the whole of 1636, when he accompanied, as physician, an embassy to the Emperor of Germany. Upon the breaking out of the civil war in 1642, Harvey attended the king, "by desire of the Parliament," as he himself tells us. At the battle of Edgehill the Prince (afterwards Charles II.) and the Duke of York were committed to his care. "He withdrew, with them, under a hedge, and took out of his pocket a book and read; but he had not read very long before a bullet of a great gun grazed on the ground near him, which made him remove his station." Harvey afterward retired to Oxford, and became again absorbed in his medical studies. Charles was a great friend to Harvey. He allowed him all sorts of animals for his experiments, and took delight in being present thereat. At Oxford the honorary degree of Doctor of Physic was conferred upon him. He was made Warden of Merton College by the Royalist party in 1645, a position which he held for a year only, as the Parliamentarians retook Oxford in 1646. Harvey at sixty-eight retired to London. The second of his great works appeared in 1651. In the following year, when Harvey was regarded by common consent as the most distinguished anatomist and physician of his age, the College of Physicians placed his statue in their hall at Amen Corner, where it unfortunately perished in the fire of London. A bust sculptured after Harvey's death adorns the theater of the present College of Physicians; another is upon his monument in Hempstead Church. Harvey added a handsome building to the college, and furnished the library with books. The fellows in their turn offered him the highest honor they were able to confer. In 1654 he was unanimously chosen president, but declined the honor. He settled his paternal estate, worth £56 per annum, upon the college, and founded the Harveian oration, which is still delivered annually by one of the first physicians of the day, according to the express wish of Harvey that "once in a year there shall be given a solemn oration to commemorate the benefactors of the college, and to encourage its members to search out the secrets of nature by way of experiment." Harvey died on June 3, 1657, in the eightieth year of his age, and was buried at Hempstead, in Essex.

The statue of William Harvey now erected at Folkestone is a bronze figure, eight feet high, sculptured by Mr. Albert Bruce Joy; it is placed on a granite pedestal, at the west end of the Lees, adjacent to Castle Hill avenue, facing the sea, and not far from the site of the house which was Harvey's birthplace. Dr. Eastes opened the proceedings, and spoke of the merits of William Harvey and his services to mankind,

STATUE OF WILLIAM HARVEY, DISCOVERER OF THE CIRCULATION OF THE BLOOD, AT FOLKESTONE.



UNVEILING OF THE STATUE OF WILLIAM HARVEY AT FOLKESTONE, ENG.



GLASGOW CATHEDRAL.—DRAWN BY S. READ.

as one of the greatest discoverers in anatomy and physiology. He then called upon Professor Owen, one of the most eminent comparative anatomists and physiologists in the modern scientific world, to unveil the statue and present it, on behalf of the subscribers, to the Mayor and Corporation of the town.

Professor Owen, in his address before unveiling the statue, explained how the methods and results of Harvey's discovery have not only laid the foundation of all progress in physiology, but have been the basis of modern scientific medicine and surgery, and consequently the source of countless blessings to suffering humanity. From this point Professor Owen passed into a disquisition on the experiments and discoveries of Harvey and his follower, Hunter, showing the value of vivisection as the helpmate of surgical research and discovery, and without which we should still be in the dark ages of science as regarded the healing profession. In conclusion, he remarked that it seemed to him to be a public duty germane to the memory of the "great vivisector" to oppose a now threatened appeal to the legislature totally to prohibit such experiments as those to which mankind was indebted for Harvey's and Hunter's great discoveries. He was prepared to prove, on all fitting occasions, the mode and degree in which vivisection imparted the power of diminishing and removing the sufferings of our fellow-men. The learned Professor concluded by presenting, on behalf of the committee and subscribers, the memorial to the Mayor and Corporation of Folkestone.—*Illustrated London News.*

GLASGOW CATHEDRAL.

In a quiet, out-of-the-way quarter of the bustling commercial city of Western Scotland, where a stream called the Molendinar, from the neighboring moorland hills, descends through a rocky ravine to join the Clyde, stands the fine old Cathedral Church of St. Mungo. It is just opposite the hill of the Necropolis or Cemetery, which is adorned with shrubberies partly screening its unsightly collection of tombs and monuments, overlooked by the memorial of John Knox. The cathedral, built in the twelfth and thirteenth centuries by the bishops of "that ilk," is one of the purest examples of the "Early English" style of Gothic architecture, which ought rather to be called "the Early British," to spare the feelings of enthusiastic Scottish patriots. It has fortunately escaped the fate of St. Andrews, where the misguided religious zealots of an age of controversial strife once came together—

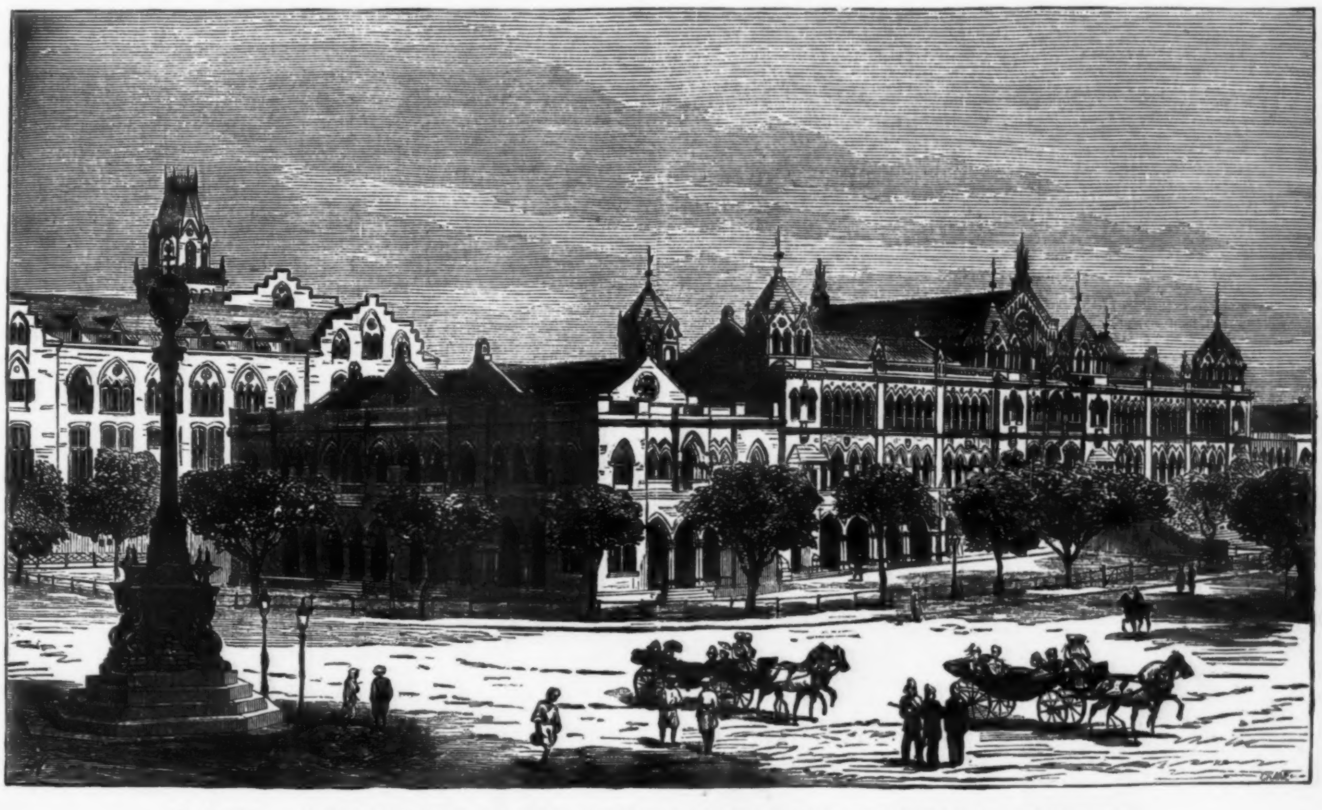
"And with John Calvin in their heads,
And hammers in their hands, and spades,
Enraged at idols, mass, and beads,
Dang the cathedral down."

The Catholic Bishopric of Glasgow was erected or restored by King David I. of Scotland, the founder of Melrose Abbey, in 1138. Bishop Jocelyn, in 1192, began the building of the present cathedral, a former church having been accidentally destroyed by fire. It was dedicated to St. Mungo, otherwise named Kentigern, one of the early Irish Christian missionaries to Scotland in the seventh century. The exterior form of the building is remarkable for the length of the nave and shortness of the transepts, differing in general appearance from other cruciform Gothic churches. The east front, where the ground falls almost precipitously to the ravine of the Molendinar, has the most imposing aspect, with its long and deep façade, massive projecting buttresses, and the lofty, narrow, lancet-shaped windows of the choir, or of the Lady Chapel. The basement underneath this part is occupied by the crypt, which has, internally, more light and air than any crypts usually enjoy. Such at least is its present condition, thanks to structural improvements made since the time when Sir Walter Scott wrote his "Rob Roy." The reader will, of course, remember how Bailie Nicol Jarvie is obliged to hold conference with the Highland outlaw in this place, then described by Scott as "an extensive range of low-browed, dark, and torchlight vaults." This crypt is really beautiful, with its richly sculptured, groined roof, and with the capitals of the pillars surrounding its piers wrought into a wonderful variety of decorative designs. It contains the tomb and shrine of St. Mungo, and the sepulchral chapels of several ancient prelates. The interior of the church above is very noble, especially the proportions of the grand pointed arch forming the choir, and the side arches that divide it from the aisles. Modern liberality has restored Glasgow Cathedral with great completeness, and has filled the windows, in particular, with some very superb works in stained glass from Munich, representing scenes of Bible history. Among the religious associations of this cathedral, it should not be forgotten that Robert Leighton, Archbishop of Glasgow in the times of Charles I. and Charles II., held the episcopal charge, though much of his time was passed in England after the Civil Wars. He died in retirement at the little rustic village of Horsted Keynes, in Sussex, where he is buried. The devotional writings of Leighton are justly esteemed by Dissenters as well as by Churchmen.—*Illustrated London News.*

GLASGOW CATHEDRAL.—DRAWN BY S. READ.

DAVID SASSOON BUILDING, ELPHINSTONE HIGH-SCHOOL, BOMBAY.

The Governor of Bombay, Sir James Ferguson, in February last opened this handsome building, nearly one fourth part of the cost of which has been defrayed by Sir Albert Sassoon, and which is named after the late David Sassoon, whose beneficence is so widely known. The Elphinstone Native Education Institution originated in 1820, as a branch of the Bombay Education Society, from which it was separated in August, 1822, and designated "The Bombay Native School Book and School Society." In 1827, the title was changed to that of "Bombay Native Education Society," which was retained till the constitution of the Board of Education in April, 1840. The schools of the Native Education Society were then incorporated with the Elphinstone College classes, and all former designations were merged into that of the Elphinstone Native Education Institution. In the year 1856 the Elphinstone College was separated from the schools, and has, by the munificent gifts of Sir Cowasjee Jehanghir, the Parsee merchant, in 1863 and 1864, been provided with a suitable building in the Parell Road, Byculla, which was completed in 1870. It was then considered that the school building was insufficient for the accommodation of the senior students who were preparing for the university. The first stone of the new building was laid in May, 1872, by Sir Seymour Fitzgerald. The work was commenced in January, 1873. Of the estimated cost of 5,800,765 rupees ($2,540,000), 1,500,000 rupees were contributed by Sir Albert Sassoon. The building has twenty-eight class rooms, besides four rooms for the use of the principal, vice-principal, and assistant masters. There are also the hall on the first floor, and the library on the third floor. The Elphinstone funds are under the charge of trustees nominated by government, and the school fees, since the year 1870, have been paid into the government treasury. The number of boys on the roll at present is 810; of these, seventy-six, or about 9 per cent, are free; the others pay in the lower school Rs. 3, and in the upper school Rs. 4 monthly. There are, in addition to the principal and vice-principal, twenty-eight assistants in the school, besides the principal's clerk. Some estimate of the condition of the school may be gathered yearly from the number who pass the matriculation examination. In the last examination fifty-three boys matriculated from this school. There is every reason to suppose that the new and commodious building will attract still greater numbers to the school.—*Illustrated London News.*



DAVID SASSOON BUILDING, ELPHINSTONE HIGH-SCHOOL, BOMBAY.

During the past summer Mr. W. G. Levison, of Brooklyn N. Y., has studied the spectra of the light of fire flies and other light-producing insects. He finds that the ordinary small species of fire fly gives a spectrum from which the blue and violet are omitted, and that in all cases examined the less refrangible rays predominate. Phosphorescent oils and glowing phosphorus give a spectrum consisting of green light only. A fire fly that is injured and glows permanently seems to give a nearly similar spectrum, but the bright light given by the insect when living affords an entirely different spectrum, as mentioned above.

THE INTERNATIONAL EXHIBITION OF ELECTRICITY.

The exhibition, which opened in Paris, August 11, is, in all respects, one of surpassing interest. An idea of the wide range of subjects illustrated by it may be given by the official classification of the exhibits. This is as follows:

1. Apparatus for the Production and Transmission of Electricity.
2. Natural and Artificial Magnets: Compasses.
3. Apparatus used in the Study of Electricity.
4. Applications of Electricity—to Telegraphy and the Transmission of Sounds—to the Production of Heat—to Lighting and to the Production of Light—to the Service of Lighthouses and Signals—to all Warning Apparatus—to Mines, Railways, and Navigation—to the Military Service—to the Fine Arts—to Galvano-Plastics and Electroplating—to Chemical Manufacture—to the Production and Transmission of Motive Force—to Mechanism and Clockwork—to Medicine and Surgery—to Astronomy, Meteorology, and Geodesy—to Agriculture—to Registering Apparatus—to the Working of various Industrial Apparatus—to Domestic Purposes.
5. Lightning Conductors.
6. Retrospective Collections of Apparatus illustrating the early investigations and the first applications of Electricity.
7. Books concerning Electric Science and its applications.

This covers an enormous field, and affords wide scope for description. I must content myself, however, with giving a slight sketch of the main features of the display.

As one approaches the Palais de l'Industrie, one's attention is attracted by the electric tramway car placed on a line from the gate of the Palais to the Place de la Concorde. This kind of vehicle is now habitually running in Berlin, and may also be seen at the Crystal Palace at Sydenham. The principle of its action is that while, on the one hand, if a Gramme machine be set in motion, it will produce a current of electricity, on the other hand, if a current of electricity be sent through a Gramme machine, this will be set in motion. Under this Siemens car there is placed a dynamo-electric machine. Electricity is generated elsewhere, and sent through it; the result being that the car is propelled. In Berlin the current runs from the engine-house up one rail, through the car, and down the other rail. Here there is a makeshift arrangement of a running wire and a running carrier designed to accomplish the same purpose.

On the floor of the great hall, half the space is taken up with French, half with foreign exhibits. Among them, those of the United States are conspicuously novel. On the ground floor there is just being completed an engine of 1,000 horse power, destined to supply energy to the numerous electric lamps which are being set up. One of these lamps is in a splendid model of a French lighthouse, which stands in the middle of the hall.

In the galleries there has been arranged a complete set of domestic rooms—dining room, drawing-room, ante-chamber, kitchen, bath-room, etc.—furnished with all the domestic conveniences to which electricity can minister, such as electric bells, signals, police and cab calls, instantaneous lights, and so on. Electricity is also caused to put in motion a very wide range of machines—turning lathe, drilling machine, automatic singing birds, and other toys, pleasure boats, balloons, etc.

The electric light is used not only directly for the purpose of illumination, but also to facilitate operations in the photographic studio, and to force hothouse fruit and flowers.

Two rooms are taken up with the exhibits of Mr. Edison. These two rooms give a remarkable impression of the man himself. He shows a wonderful array of instruments, among which are apparatus for measuring the resistance of lamps; for measuring the energy consumed by lamps; rheostats, in which the resistance is varied by altering the pressure on carbon comprised in the circuit; a thermo-galvanometer; relays of all kinds; printing telegraphs for private lines; printing telegraphs for the stock exchange; an automatic system for transmitting handwriting; the

quadruplex system of telegraphy, according to which two messages may be sent along the same wire at the same time, and at the same time two messages be sent along the same wire in the opposite direction; loud-speaking telephones; the motograph (a rolling cylinder lightly touched by a metallic point, the friction increasing when a current passed through it becomes stronger; variations in the current thus cause variations in the friction, and therefore in the speed of rotation of this cylinder; voice at a distant telephone produces a loud-speaking effect at the point of friction); many forms of telephonic commutator and relay; microtasimeter, by which may be measured the heat coming from distant stars; electric motors for pumps, sewing machines, domestic fans, etc.; electric pens; magnetic ore-assorters; cigar-lighters; some new systems of bells, etc., etc.

M. Gaston Tissandier, who is so well known for his enthusiasm as an aeronaut, shows a couple of curious short cigar-shaped balloons. These he drives by means of Planté's secondary piles, in which electrical energy is stored up. For propelling and steering a balloon some means of applying force are necessary; and these stores of electricity are better than a little steam engine of any model, beause there is no smoke, no coal to carry, no risk of fire.

Fire-alarms in theaters and elsewhere, and systems of clocks connected with one another and regulated by electricity so as to keep going at the same rate, are well illustrated.

When the exhibition opens in the evening we are promised the pleasure of standing in the Palais de l'Industrie and listening to the performance in the Théatre Français or at the Opéra. This would have seemed four years ago like an impossible dream.

In the Spanish department I find, among other things, a thermometer which, if over-heated, gives an electric alarm; a lock which, if it be tampered with, or any but the proper key is used in it, does the same thing; a contrivance which gives warning when a river is rising in flood; and also a piece of apparatus which indicates at once, in the process of artificial hatching, any excess or defect of temperature.

The Belgian exhibit is very fine. An interesting feature in it is the electric chronograph for determining the speed with which a shot passes through the bore of a gun. The Royal Observatory at Brussels is connected with the Palais de l'Industrie, and there are recorded in Paris the temperature in Brussels, the humidity of the air there, the rainfall, the direction and the mean force of the wind, and the barometric pressure. We have also apparatus for the precise measurement of length, for detecting copper in bread, for playing the organ at a distance, etc.

The American exhibition is very rich in all kinds of telephones, microphones, photophones, electric lamps, and electric motors, and it illustrates engraving on metal by the union of photographic and electric processes, apparatus for the treatment of gold ore, for silkwinding, etc., etc.

The Swiss Confederation send a multitude of ingenious instruments and preparations. The Italians send a very interesting collection—interesting in its ancient past, for Italy is the birthplace of electrical science in its modern phase; interesting in its modern past, for during the last twenty years Italy has undergone a second *renaissance*, and is now one of the leading scientific nations of Europe. I may just mention the collection of instruments for earthquake registration, and that for stenographic reporting, which is very curious.

Space fails me altogether to give anything like a satisfactory sketch of the French, the English, and the German departments. These comprise 1,214 groups, each of which may contain from one to twenty instruments.

The English department is predominantly practical—telegraphy, submarine cables, railway safety appliances, and the like, occupy a very large proportion of the space, together with the instruments of precision devised by Sir William Thomson and others for bringing these to a practically successful issue.

The German department is more instructive, and represents nearly every part of electrical science with great fulness.

The French department, comprising 943 groups of objects, is of surpassing interest; but space again would fail me altogether in the attempt to give anything like a just idea of its treasures. The following are the names of the exhibitors:

1. Compagnie Générale Belge de Lumière Electrique (Soleil lamp). 2. Compagnie Générale d'Electricité, Paris (Werdermann lamps). 3. Do. (Jamin lamps). 4. Do. (Reynier lamps). 5. Do. (Jablochkoff lamps). 6. Brush Light Company. 7. M. de Méritens. 8. Sautter, Lemonnier, et Cie. (Gramme). 9. Société Espagnole d'Electricité (Gramme). 10. Siemens Brothers. 11. Compagnie Parisienne (Wilde). 12. Maxim lights. 13. Jaspar, of Liége. 14. Gérard, of Paris. 15. British Electric Light Company (various). 16. Mignon and Rouert, Paris (Gauduin carbons). 17. Société Lyonnaise (Mersanne system, Bersin and Boulard systems). 18. Fyfe, London (Pilsen's and Joel's). 19. Swan. 20. Edison.—*Journal of Gas Lighting.*

A correspondent of the *London Times* says: Of the sixteen classes into which the objects exhibited are divided in the catalogue there are three which promise to be more attractive than any others to the general public. These are telegraphy, electric lighting, and the application of electricity as a motive power. M. Cochery has a magnificent collection of all modern appliances in telegraphy. But the electric lights will not be ready for a week longer, owing to the backward state of the steam engines and other causes. I propose to give some idea of the exhibits referring to the application of electricity to the driving of machinery.

Ever since M. Gramme introduced his beautiful machine for generating the electric current, his principle has been adopted in a host of other inventions. Shortly afterwards a new value of the machine was found. I well remember, in 1875, returning from a prolonged absence from England, I had occasion to write to the late Professor Clerk Maxwell, and incidentally asked him what was the greatest discovery of late years. He replied that, in his opinion, the greatest discovery was "that a Gramme machine could be reversed"—*i. e.*, that when a current was passed through the machine it might be used to drive machinery. The belief of the Professor was shared by many others, and hundreds of people have been since then engaged in applying this new means of transmitting power to diverse purposes. The Electrical Exhibition contains a large number of these, many of which can even now be seen in action, but a complete notion of these applications cannot be gained until the steam engines, the source of nearly all the electricity to be used in the Exhibition, are in a more advanced state. I will, however, attempt very shortly to give some idea of the most interesting examples in this department.

A great deal of popular curiosity will doubtless be excited by two thoroughly French toys on a large scale, both made by M. Trouvé. The first is the electrical boat, which is a full-sized boat for three people, having, attached to the near end of the rudder, a screw driven by a small electro-motor. The screw passes through a void space in the rudder. The motor is fed by three large bichromate cells. The mode of attachment of the screw causes it to assist the rudder in turning the boat, so that M. Trouvé has been easily able to float around the artificial pond which surrounds the lighthouse in the center of the building, and to pass under the picturesque arches by which it is spanned at the rate of about a mile an hour.

The other is the electrically-propelled balloon of M. Tissandier. It is an elongated balloon, three meters long and one and a third in diameter. It is filled with hydrogen, and has a screw at the rear, driven by an electro-motor, designed by M. Trouvé. It can also carry a couple of the secondary cells of M. Planté. A wire is suspended across the building from one gallery to the other, and the balloon rises above this wire and travels along it when the current passes. A fin placed in front prevents it from swaying. But the motion is very slow, and at present the machine is little more than an electrical toy.

Still more interest will, however, be excited by the tramway-car driven by electricity, the invention of Messrs. Siemens. In this tram car, which runs from a wooden station on the Place de la Concorde into the Exhibition, the current is generated by a powerful dynamo-machine within the building. It is then carried by wires mounted on strong posts, from which it is tapped by carriers on the car, whence it descends to beneath the center of the car. Here the current, passing through a dynamo-machine, sets it in rotation, and by a chain connection this machine is geared to the axles of the wheels. The velocity of rotation is reduced to one-third by this gearing. The chain connections are all on one side in the case of both axles. There is also an arrangement supplied for taking the current directly from the rails; but it must be very rarely that such a means could be utilized on an ordinary tramway, and at present it is discarded. The appearance of the car is very handsome, and shows few external signs of the power which may be generated within it. Such a car might be fitted with the secondary batteries of M. Faure, which might be placed under the seats. The car would be then self-contained, and there would be no necessity for having either the aerial wire or the conduction through the rails. Such a self-contained car was actually constructed and tried in Paris some months ago, but serious difficulties were then encountered, which, however, I have reason to believe, will soon be overcome, and then we shall have an opportunity of seeing a car running on a tramway and carrying its own electrical store of energy.

Although the electricity thus used would, so far as we are at present advanced, be derived from steam, still, in spite of the loss by conversion of steam into electricity, it might in many cases have advantages. Every one will easily see what a comfort it would be to have our underground railways driven by a power which does not contaminate the air. Even on many ordinary railways the gain might be considerable. Several years ago Captain Douglas Galton, in the concluding paragraph of his report on experiments conducted by himself and Mr. Westinghouse on trains going at high speed, says:

"The advantage which thus evidently ensues from utilizing the adhesion of every wheel of a train suggests the further consideration as to whether it would not be a more scientific arrangement as well as more economical in regard to the permanent way of railways to utilize the adhesion of every wheel of a train for causing the train to move forward, instead of depending for the moving force upon the adhesion of one heavy vehicle alone, viz., the locomotive."

This acute suggestion could certainly be easiest applied by having an electric motor on the wheels or axles of each carriage. The results would be a saving in the wear and tear of the permanent way, a diminution of shocks and injuries to passengers and goods, and a facility in going round curves. Besides this, the wheels would not slip when going up very steep inclines, and in starting from a station speed could be got up in a small fraction of the time now required to do so. These considerations alone, independently

THE INTERNATIONAL ELECTRICAL EXHIBITION, PARIS, 1881.

of its many other applications which can even now be realized, must lead us to view with satisfaction every step toward so desirable a consummation as the storage of electricity. The Faure battery consists of two sheets of lead coated with red oxide of lead, and separated by a piece of felt. The two sheets are placed together in a cell and moistened with a diluted solution of sulphuric acid to increase the conductivity. Any number of these cells may be connected together to increase the power. After a current has been made to pass through these cells for some time the nature of the oxidation of the lead is changed, and it becomes capable of giving off an electric current. The battery is really identical with that of M. Planté, invented many years ago, except that he produced the oxide by electrical means, whereas M. Faure applies it directly. This is certainly a step in the right direction, but there are still many objections to the general use of a secondary battery. If, however, it be true, as the company assert, that the cost of charging one of these cells "will probably shortly be reduced to a penny, or even less," and if their statement of the efficiency of the cells be exact, I am sure that every one who sees the beautiful soft light which Mr. Swan is exhibiting here, worked by the Faure batteries, would wish to apply such a light to his domestic purposes. The Maxim and Lane-Fox lights may be as good, but Mr. Swan's is the only one at present exhibited. The convenience of having such a source of power at command is also shown in the applications which are to be seen in the exhibition to the driving of sewing machines, embroidery machines, turning lathes, etc., not to speak of velocipedes and tricycles, which will presently arrive at the exhibition.

In the electric brake of M. Achard, applied to railway carriages, there are upon the axle of each pair of wheels two rings of iron, about eight inches in diameter and two inches wide. Besides this there is a second and independent axle, with two rings, one foot in diameter, facing the rings on the wheel axle. These rings, however, are the two extremities of a powerful electro-magnet, which can be excited by a coil of wire, the ends of which can be connected with the current generated in the locomotive by means of two pair of strong copper springs. So long as there is no current passing the independent axle maintains a fixed position, and the brake is kept away from the wheels by strong spiral springs. So soon, however, as the current is allowed to pass, the rings at the two ends of the independent axle are converted into magnetic poles, which attract the revolving rings on the axle of the wheel, from which they are separated by only one-eighth of an inch. The so-called residual force of the rings produces a rotary force on the poles of the electro-magnet. The independent axis revolves and winds up a chain which is connected by levers with the brake, so that in a short time a powerful force is applied. A simple form of variable resistances is supplied in the locomotive, so that the engine-driver has merely to turn a wheel more or less to increase or diminish the power of the brake.

A most interesting application of electricity to motive power is seen in the plowing machines of the late M. Menier, exhibited by M. Félix, which do the work of about eighteen horses. In these are employed a pair of the large form of Gramme machines, which were first made for them, but which have since become the usual form for Gramme motors. The ring armature has four poles, opposite which are the poles of the fixed magnets, each fed by two arms, giving somewhat the appearance of a square with all four sides prolonged each way, and inclosing a circle. All the eight arms are connected by an octagonal framework of a very solid form, forming part of the field-magnets. This is undoubtedly the most compact form of Gramme machine which has been made. This machine is at one end of the electrical locomotive; at the other end is the gear for directing the motion of the whole engine forward or backward in the field to be plowed, or for stopping it and putting in action the machinery for winding up the large coil of wire rope, which coil is in the middle of the engine. The wheels are, of course, wide, like those of a traction engine, so as to be able to pass over plowed land. One of these engines being stationed at each end of the field, with a triple-shared reversible plow between them, the electric contact is made, the Gramme machine turns round and winds up the wire, and so draws the plow share along. When the plow has reached the end of a furrow the engines advance a step by gearing the Gramme machines to the proper wheels, the plow is tilted so as to bring three other shares into action, and the engine at the other end of the field pulls it in the reverse way.

So great a demand has lately sprung up for small electric motors that Messrs. Siemens have manufactured a large number of their machines on a very small scale, some of which are now to be seen in the exhibition, measuring only about six inches square and two inches deep.

A host of other electric motors, of all degrees of power, are exhibited by inventors in nearly every section. This clearly shows that electricity has come to be looked upon as a really useful source or transmitter of power, at least by many nations. The French especially seem to realize the fact that the electric light has at last obtained a firm foothold, and that even now there is a new direction in which the application of electricity will soon be very greatly extended.

IMPROVEMENTS IN THE TREATMENT OF FLUID BLAST FURNACE SLAG.

By A. D. ELBERS.

FURNACES in which iron ores in contact with charges of fuel and flux are smelted down to pig iron are called blast furnaces, and the molten earthy dross which separates from the metallic iron while in fusion, and which gathers, on account of its lighter weight, on top of the metal, is called slag or blast furnace cinder.

In the United States the output of pig iron averages perhaps somewhat above that of the weight of the slag, still over 3,000,000 tons of the latter are yearly produced, whereof only a small part is utilized, whereas the accumulation of the remainder is a decided incumbrance.

Though the ballasting of roads, filling in of embankments, etc., occasionally afford a ready market for the slag of some furnaces, the money value derived therefrom is no adequate return for the cost of the heat which was used in melting the slag, the total cost of which is to this country nearly a million tons of coal yearly.

The utilization of this waste heat, which is now generally allowed to escape from the slag as best it can, thereby actually injuring the quality and properties of the latter even for the commonest use, is therefore of the highest importance, and all attempts to render blast furnace slag valuable should be in the direction of manipulating it in its state of fusion, and of either utilizing its heat directly, or to regulate the rapid escape of heat in such manner as to obtain the most desirable state of molecularity in the solidified slag, or that condition in which the latter will be most useful.

The conversion of fluid slag by steam into "mineral wool," by water into "slag sand," its use in the manufacture of bottle glass, and the recent French experiments of running the slag from the blast furnace into rotary gas furnaces for further conversion into artificial stones are all efforts in the right direction, but as yet absorb only a comparatively small quantity of slag abroad, and probably not one per cent. of the yearly supply in this country.

Usually the slag is allowed to run through gutters or along a chute into furrows on the ground, and then becomes quickly chilled on the surface, while from under the still liquid mass runs onward and breaks out in new streams, which become crusted over in their turn, until the flowing supply is exhausted, when also the cores of the slag streams solidify.

It is obvious that the almost simultaneous transformation in the same piece of liquid into solid and irregular contraction of the already solidified crust, while the slag is undergoing a loss of heat of nearly 2,000 degrees Fahr., all within about ten minutes, are less apt to promote molecular uniformity than an incongruous material of haphazard shape.

It must be remembered here that slag at red heat is by no means as ductile as glass, but rather "red short" or "refractory;" that the composition of the average blast furnace cinder contains much more lime and less of silica than glass; and that the vitreous condition of slag may or may not be obtained, according to the manner in which it is cooled, as can be best illustrated by a closer examination of the slag product, "mineral wool."

If this wool is made from very "limy" or "calcareous" slag, poor in silica, and put into a bottle which contains diluted vinegar, the fine wool threads will entirely melt away or dissolve in a day or two, whereas the slag globules which are generally found in the wool will scarcely change at all, if kept in the bottle for months. Still the globules and threads are of exactly the same composition, only the globules offer in proportion to bulk a smaller surface to the action of the acid, and, having been suddenly chilled, are more vitrified on their surface than the elongated and slower cooled threads.

Compactness and vitrifaction of the slag prevent, therefore, its gradual decay and disintegration under exposure to the weather.

The following description of a new method of treatment, for which letters patent have been recently granted to Mr. A. D. Elbers, of Hoboken, N. J., through the agency of Messrs. Munn & Co., may incite a more general investigation of the possible uses to which blast furnace cinder can be put.

It is proposed to run the fluid slag from the furnace into a revolving spider, resembling an ordinary carrousel; instead of the platform for wooden horses and riders, the circumference of the apparatus is encircled by an annular iron trough or gutter, into which the slag is to flow, while the carrousel swings around.

Assuming the slag yield from a given furnace to average 5,000 pounds at every tap, and this quantity to be poured out to a depth of 6 inches into a gutter 1 foot wide, or to a depth of 3 inches in a gutter 2 feet wide, the capacity of the gutter would have to be about 30 cubic feet, the outer circumference 60 feet, and the diameter of the whole apparatus about 19 feet.

If the apparatus made five revolutions per minute (as an ordinary carrousel of that size can be made to do by hand power) the slag flow would be distributed over a distance of 300 feet in one minute, or over 2,100 feet in seven minutes, which is about the time in which the 5,000 pounds of slag would have run in.

In this manner the slag will be cooled quickly, and the hotter or liquid strata will always be on top of the colder and already solidified layers, and thereby insure solid weld, density, and compactness of the whole mass.

While the various forms into which the slag may be cast will suggest themselves in practice, that shape which may be most desirable for *railroad ballast*, presumably the most extensive application to which slag can be put, will certainly be obtainable at about the same cost as removing cinder in the old way. Common ballast for railroad construction and maintenance of way is not generally procured further off from where it is to be used than 20 or 30 miles; the possibility of getting material of a shape and quality to suit the more exacting requirements of first-class roads, as regards freedom from dust, preservation of cross ties, and stability of road bed, may, however, allow of more extended transportation, and thereby render available the slag from blast furnaces, which would otherwise be considered too far off to draw a supply from.

By this method slag can be cast into many crude shapes—especially suitable for *culverts* and similar constructions—at a merely nominal cost.

ON SEWAGE IN OYSTERS.*

By CHARLES A. CAMERON, M.D., M.K.Q.C.P.I.

LARGE numbers of oysters collected by dredges off the coast of the county of Wexford are laid down in "beds" on the northern shore of the Bay of Dublin. When fully developed in these "Clontarf beds" they are removed for consumption to Dublin and other places. Formerly the Clontarf oysters were thriving mollusks, but during late years they have not done well, and great numbers of them die shortly after their translation from their native habitat.

Owing to the recent construction of many large sewers, the contents of which are discharged into the northern side of Dublin Bay, and also owing to the rapid development of the water closet system in Dublin and its suburbs, the water of the bay is yearly becoming more polluted with excrementitious and other offensive matters. These obnoxious substances are thrown up on the fore-shores of the bay. The river Liffey, which is the chief carrier of filth to the bay, is steadily becoming more and more polluted. It is only a generation ago when mullets and other edible fishes were numerous in the river, where now they are rarely seen. Near the estuary there were numerous beds of oysters, which have become extinct, partly owing to their sites being now the "berths" of ships, but also owing apparently to the great pollution of the river.

An examination of some oysters taken from Clontarf and of the water which covered them has afforded rather startling results. The oysters—a large and coarse variety—were taken from a place where the tide covers them to a height of about ten feet, and which during low water is nearly dry. In most of the oysters the brine had no peculiar odor, but in a rather large proportion there was a very slight, but distinctly fœtid odor, while in a few cases there was a strong and unmistakable odor of sewage. Examined microscopically the liquid in the oysters which had a fœtid odor was found to swarm with micrococci and other low organisms similar to those usually present in sewage.

The sea water taken at the oyster beds when the tide was fully in was subjected to chemical analysis, and the following were the results arrived at:

One imperial gallon (70,000 grs. weight) contained, in addition to water—

	Grains.
Volatile matter at a red heat (a)	303·000
Fixed substances at "	2110·000
Total solid matters	2413·000
(a) Yielding—Albuminoid ammonia	0·009
Saline ammonia	0·010

One gallon of the water taken, when the tide was fully out, from little pools containing oysters, was found to contain the following, exclusive of pure water:

	Grains.
Organic and volatile matters (b)	242·000
Fixed mineral substances	1406·000
Total solid matters	1648·000
(b) Yielding—Albuminoid ammonia	0·090
Saline ammonia	0·300

Thus it will be seen that the albuminoid ammonia was ten times, and the saline ammonia thirty times, more abundant in the water taken when the tide was out, clearly proving that it was in great part composed of sewage.

The large amount of solids in the "low water" may be accounted for by the evaporation of the surface water—the weather at the time being warm—concentrating the saline matter in the remaining water. The water taken when the tide was out had a decidedly sewage odor, and teemed with low forms of life.

Marine crustacean and molluscous animals are among the most active scavengers of our coast; they devour not only animalcules, but also particles of dead animals and vegetable matter contained in the water. In the case of crustaceans, this decomposing organic matter becomes reorganized into living tissue, and, therefore, these animals furnish wholesome food to man.

Lobsters and crabs are also always cooked before being eaten. Oysters, cockles, mussels, and other lamellibranchiate mollusks are often eaten uncooked, and their shells inclose a liquid which is more frequently drank uncooked than cooked. Although oysters when deserted by the tide instinctively keep their valves closed, they do not invariably do so, and, therefore, at low water, sewage trickling down the shore is likely to find its way into the interior of the open oysters. Now, if potable water and milk be vehicles in which it is possible that the germs of typhoid fever may exist, why may they not be sometimes present in the so-called juice of an oyster or cockle?

Any one may satisfy himself that sewage is constantly discharging over fore-shores, in which various edible molluscs have their abiding place; and it is in the highest degree improbable that animals can always resist successfully the entry of polluted brackish water into their calcareous dwellings.

Under all the circumstances we confess that we prefer to eat oysters taken from the lonely shores of Clare and Kerry, rather than from the sewage-polluted estuaries of rivers like the Liffey and the Thames. It may be that the illness which so many persons have experienced after swallowing oysters, believed to have been stale, was really due to the presence of sewage matter in the juice of the mollusks.

* From the Report on Public Health, July, 1881. Reprinted from the *Dublin Journal of Medical Science.*

CLARIFYING OLIVE OIL.

THE olive oil product of California is rapidly increasing. According to a correspondent of the Santa Barbara *Press*, the common method of filtering the oil employs a series of five or six boxes, one above the other, each with cotton batting in the bottom. The oil passing the sixth will be beautifully clear and ready for market. The correspondent uses cylindrical tin vessels, holding about three gallons each, one fitting in the other in tiers of three, with fine wire sieves in the bottom of each. On these sieves he places two or three layers of cotton batting. The oil is passed from one tier to the other until clear. The clarifying can be done by the sunlight also; it can be bleached and made much lighter in color, but not without injuring it. The oil is better when new and fresh, and what is gained in the appearance by its remaining a longer time in the tank is more than lost in its freshness and delicacy of flavor.

The cost of the machinery used in the making of the oil is: Drier, $150; mill, $250; two presses, $500; two tanks, $200; filterers, $50; corker, tin foiler, $50; wooden building, $40. Total, $1,000.

NEW POLARIZING APPARATUS.

PROF. E. LOMMEL describes in *Wied. Ann.* a new polarizing apparatus, in which two plates of platino-cyanide of magnesium, cut perpendicularly to the optic axis, are used as polarizer and analyzer, just as in the tourmaline pincette. Such a section of the crystal transmits a blue light, which, when the angle of incidence exceeds 2°, is found to be perfectly polarized in the plane of incidence, and it therefore can be used, if tilted to that extent out of perpendicularity to the axis, as a polarizer for a pencil of parallel blue rays. One curious point in respect to the behavior of a thin film thus prepared is the following: Let ordinary non-polarized light be looked at through the crystal while the latter is normal to the line of sight. A white central spot, perfectly circular in form, and non polarized, is observed in the middle of a blue field, which is polarized at every point radially. The only other crystals which can be used for polarizing pincettes are the tourmaline and herapathite (iodo-sulphate of quinine); the point of difference between these and the platino-cyanide of magnesium is that while the two former (which are negative crystals) absorb the ordinary ray, and must therefore be cut parallel to the optic axis, the latter absorbs the extraordinary ray, and must, therefore, be cut at right angles to the optic axis.

THE MANUFACTURE OF OXYGEN FROM ATMOSPHERIC AIR.

THE economic manufacture of oxygen is one of the problems that has engaged the attention of chemists and engineers for a long time, without a very exact account of its practical importance being taken into consideration.

No one is ignorant of the fact that nitrogen plays only a passive and often even a retarding role in combustion, in various industries, while oxygen is the active element of it. It is evident, then, that the discovery of a process which shall permit this last-named gas to be obtained at a low cost for industrial purposes is called upon to render great services and to be followed by numerous applications. The reception given by certain members of the Society of Civil Engineers to a communication made by Mr. Guitton on this subject does not appear to justify our mode of seeing, and we must confess that we were surprised at the observations that were made during the course of the discussion.

Without desiring to enter into useless observations in regard to the matter, we persist in believing, from the researches made by the inventors at the works at Passy, that oxygen will not be wanting in applications. It would be impossible to hesitate to believe that metallurgy, the manufacture of chemical products, bleaching, and lighting are industries which will be disposed to take advantage of encountered the same kind of difficulties as those which present themselves at present with regard to the application of the Thomas Gilchrist processes of dephosphorization?

Outside of metallurgy, oxygen will certainly find its application in manufactories of chemical products. It is clearly indicated for the preparation of sulphuric acid, the costly and cumbersome materials of which it will permit of reducing; and if, in addition, there be introduced those electrical actions of which so little advantage has hitherto been taken, we may expect results which will be absolutely new.

Finally, in the important industry of bleaching, there is reason to think that oxygen, pure or ozonized, in combination with decolorizing chlorides and hypochlorites, will modify the somewhat superannuated methods in use, and bring about a twofold economy of time and money.

We will not dwell upon lighting; although, of all applications, it is the one that presents itself first to the mind, and the one that in our opinion will overcome the most difficulties of detail. However, with the tendency which at present leads the public to unceasingly increase the consumption of light as the quality is improved, there is reason to think that oxygen will find something to glean in that field for whose possession gas and electricity are disputing.

It has seemed to us necessary to point out in some detail the possible and immediate applications of this oxygen for and thus transformed into sulphide of barium. The reaction is expressed by the formula:

$$BaOSO_3+2C=BaS+2CO_2$$

The crucibles are then emptied into reservoirs of cold water, wherein the product is dissolved. The solution is then treated with commercial nitric acid in closed iron vessels having an aperture for the escape of the hydrosulphuric acid, and the latter is lighted on its exit so that it may cause no inconvenience. There is thus formed nitrate of baryta, conformably to the formula:

$$BaS+A_2O_5HO=BaOA_2O_5+HS.$$

This is crystallized in the open air and dried, and the crystals are placed in covered crucibles of refractory earth, and the product is slowly calcined in a special furnace.

The golden nitrous vapors which are disengaged are either collected or allowed to mix with the atmosphere, according to the importance of the manufacture. The calcination being finished, the product is allowed to cool, and there is obtained caustic barytes, which is quickly transferred to the retorts that are used in making oxygen or to well-stoppered flasks. The barytes thus prepared may be estimated as costing about $23 per 100 lb.—a figure which might be reduced considerably in a continuous manufacture of this material on a scale of some importance. The process of preparing oxygen by barytes is cited in all chemical treatises, but care is always taken to add that the material at the end of a certain number of operations loses its property of absorbing oxygen and must be renewed.

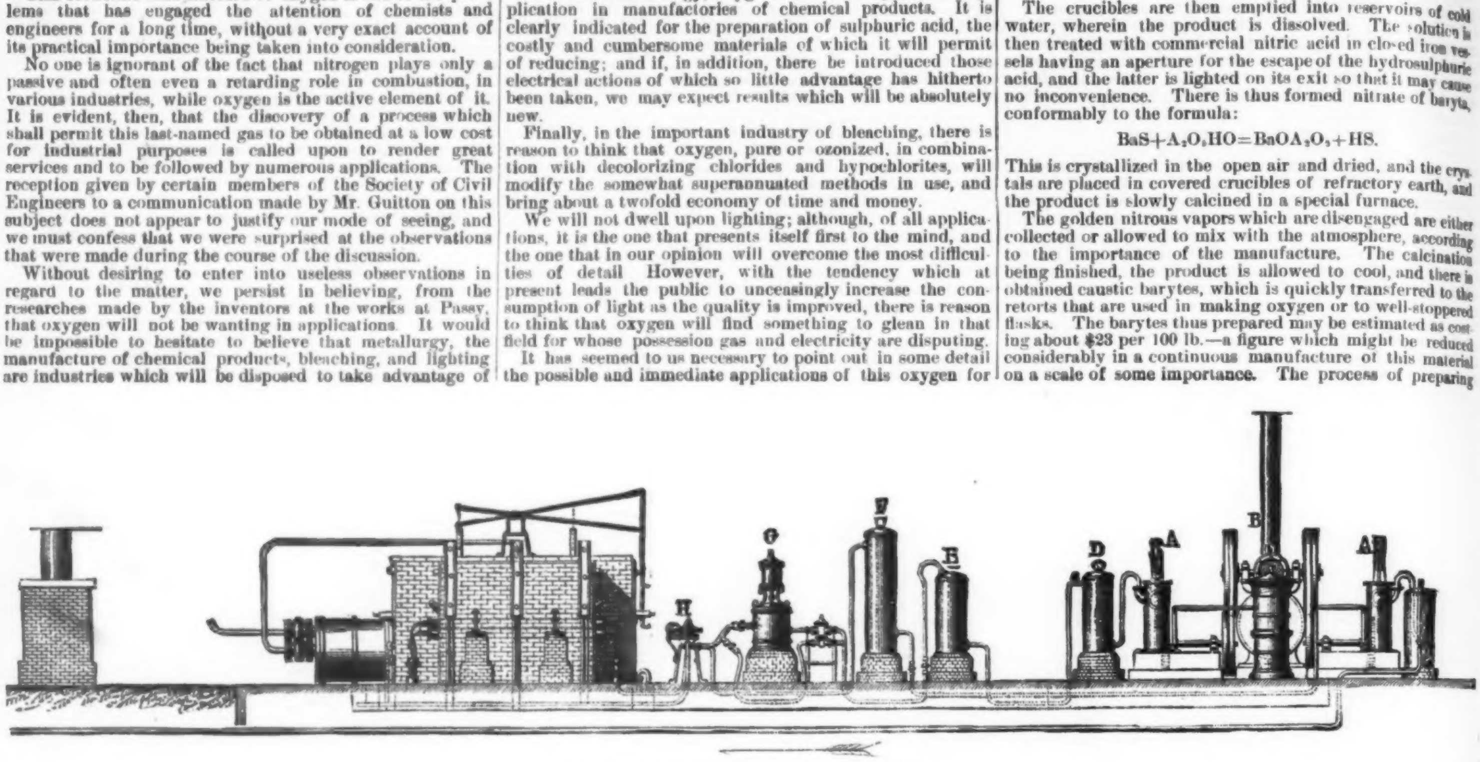


FIG. 1.—LONGITUDINAL ELEVATION.

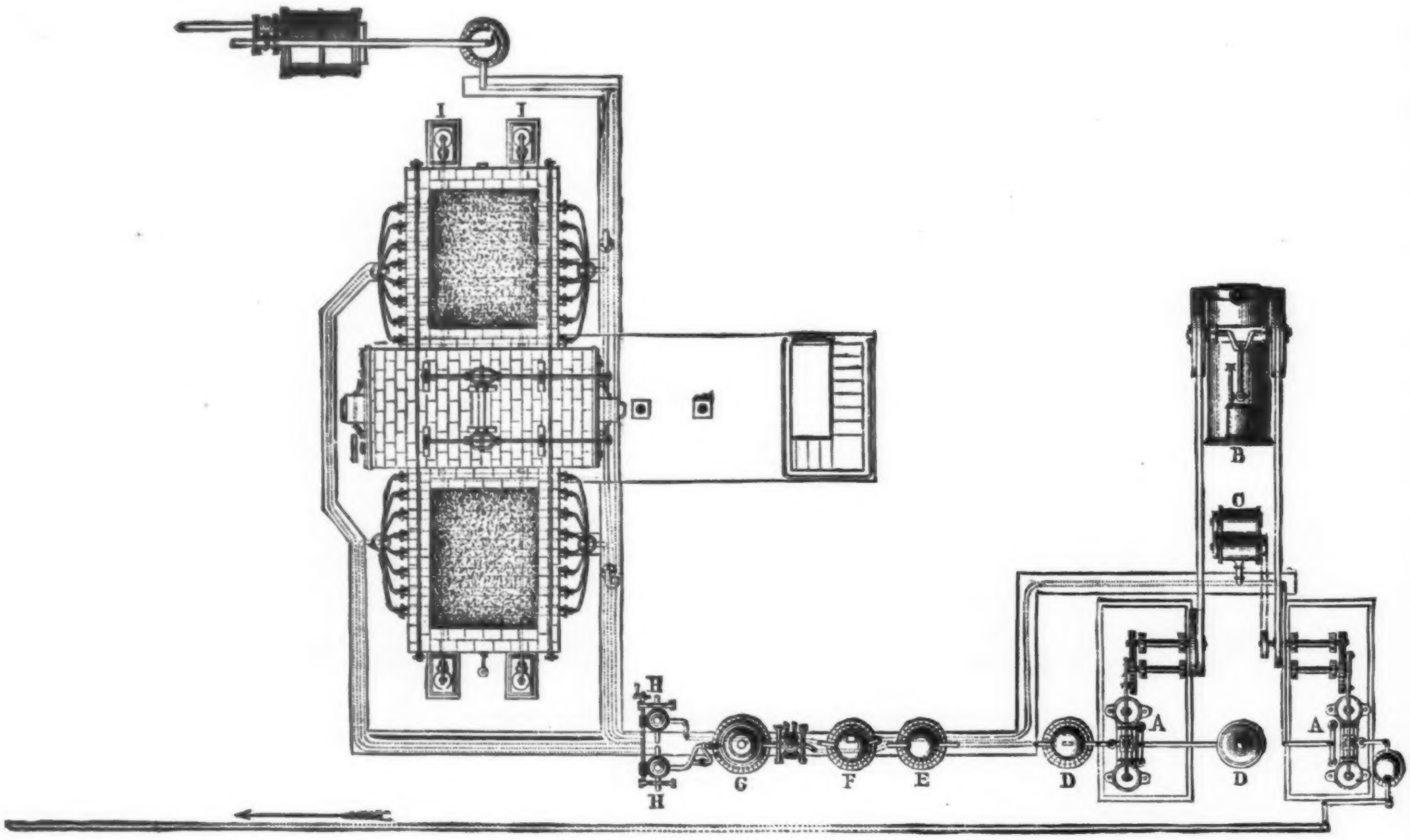


FIG. 2.—GENERAL PLAN-VIEW.

THE MANUFACTURE OF OXYGEN FROM ATMOSPHERIC AIR.

this discovery the day that it is put within their reach and arranged so as to meet the requirements of their work.

The melting of metals in the crucible by the use of oxygen is becoming a quick and simple operation for which there is no need of having recourse to forced air. The blast-furnace will be radically transformed by the introduction of oxygen instead of the mixture of 80 per cent. nitrogen and 20 per cent. oxygen that is given us by *Nature*. So, also, with the Siemens-Martin furnace, and the Bessemer converter, in which hereafter it will be possible to attain temperatures much greater than those now employed.

Here presents itself the great objection made by those who find that everything is for the best in this best of worlds: "What will become of furnaces submitted to such a heat? Refractory bricks and the cast iron bars of the fire-place will never be able to resist it, and the furnace will be quickly put out of service." Without doubt if pains are not taken to adapt the material to the power of the combustible, disagreeable surprises must be expected; but why should not refractory materials be made which would be capable of resisting the action of oxygen as well as the bricks at present in use resist that of air?

Is there need of recalling to mind that, in the same way, the manufacture of steel by the Bessemer converter which the Society of Civil Engineers has found scarcely anything more than criticisms and slightly encouraging observations. This industrial progress merits more, in our opinion, than a mere success of approval, and, from what we know of the results already obtained, it is allowable to think that the inventors will not have to wait long to gather the fruits of their labors and perseverance.

The important points which constitute the ground of the Messrs. Brin Brothers' process are summed up as follows:

1. Preparation of the air in order to render it easily decomposable by barytes.

2. Application of force pumps or of blowers or of ejectors to facilitate the peroxidation of the barytes.

3. The use of a vacuum or of suction pumps for the extraction of the oxygen after peroxidation.

4. Special arrangement of pyrometers permitting of the temperatures of the furnaces being regulated automatically.

5. Finally, the preparation of the barytes itself.

According to the information communicated to the Society of Civil Engineers, the barytes is extracted from the ordinary sulphate of barytes by a series of operations that it is well to recall.

Mixed with 25 per cent. of its weight of powdered charcoal, the sulphate is brought to a white heat in the furnaces

Such is not the case with the barytes which has undergone the treatment above mentioned, and which constitutes the originality of the Brin process. The material appears to preserve for a long time the molecular state which facilitates peroxidation, and after four hundred successive reactions exhibits under the microscope no appreciable change of structure.

The accompanying figures show the arrangement adopted in the apparatus at the Passy Works. The barytes is placed in metallic retorts united in groups of fifteen in two furnaces heated with a gaseous combustible. The temperature is regulated and kept uniform by a pyrometer, the arrangement of which may be readily understood by a glance at the section of the furnace. It is a metallic bar whose expansion at one extremity regulates the action of the lever, and consequently the aperture for the admission of air.

The succession of operations to which the air is submitted to arrive at the production of oxygen is so simple that it is only necessary to glance over the cuts to understand it. The blowers which serve to drive the air into the retorts to per-

oxidize the barytes, and the force pumps which send the oxygen from the retorts to the gasometer, are actuated by a movable steam motor. During the passage of the gas special decarbonizing and expansion apparatus remove the traces of carbonic acid and bring the fluid to a normal pressure.

It has been found during the course of manufacture that the reactions between the barytes and the air take place so much the better when the latter contains a certain proportion of humidity before it enters the retorts. Hence the use of a saturator designed to bring the air to the proper hygrometrical state.

At its inception the Passy Works operated night and day for more than three months, the gas-generating furnaces being heated with coke; and, under these conditions, the product obtained at each operation was 142·5 cubic feet of oxygen per 100 kilos (220 lb.) of barytes treated. Ten operations on an average were performed every twenty-four hours, thus giving a daily product of 1,425 cubic feet of gas per 100 kilogrammes.

As a consequence of various improvements, it has been possible to carry the production per 24 hours up to 17,800 cubic feet without increasing the expense of manufacture. For a daily production of about 1,000 cubic feet the cost price of the oxygen amounts to about three dollars. But it would be easy, profiting by the experience already gained, to add to the works so as to produce 35,000 cubic feet per day without increasing the expenses of the first establishment or of the manufacture, and the cost per 1,000 cubic feet might thus be brought down to about one dollar.

It may be readily conceived that the more the production goes on increasing, the more the cost per cubic foot will diminish.

We shall limit ourselves at present to these details, but shall keep our readers informed as to the results obtained from the industrial application of the agent under consideration.

EXPLANATION OF THE FIGURES.

Longitudinal Elevation and General Plan View.—A, Letestu pumps, B, 9 horse-power steam motor; C, Roots blower; D, quicklime decarbonizer; E, F, expansion apparatus; G, saturator; H, distributing cock; I, pyrometer.

The arrows denote the direction toward the gasometer.

Furnace.—*l*, the bar of the pyrometer; *m*, cover plate of air inlet; and *o*, the lever by which it is suspended.

Arrow No. 1 indicates the entrance for the air; No. 2, the entrance for the oxide of carbon; and No. 3, the exit for the flames.

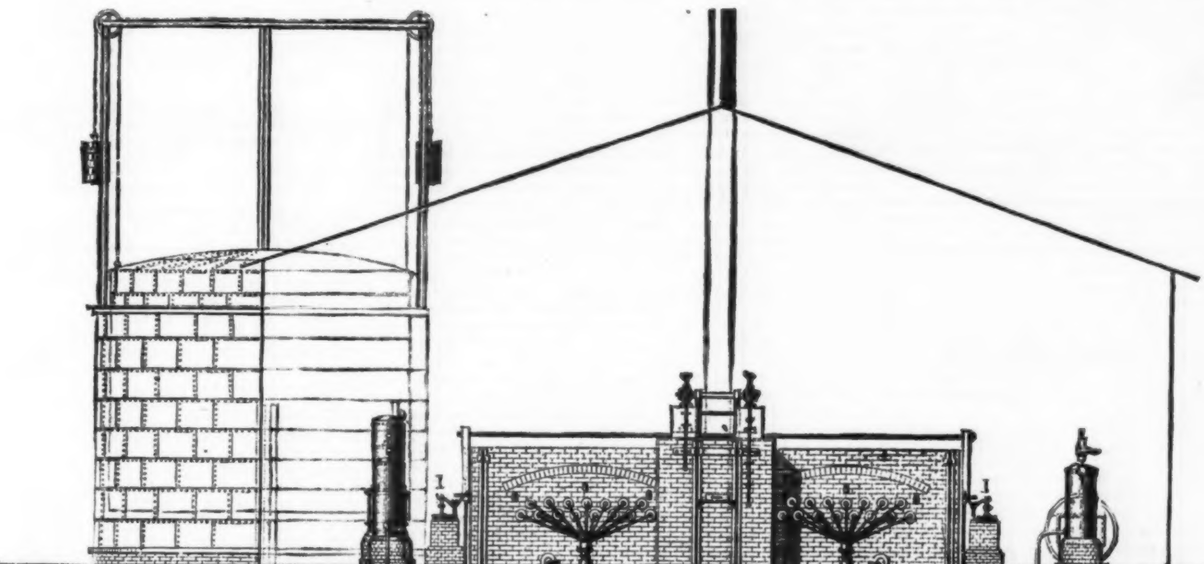


Fig. 3.—TRANSVERSE SECTION.

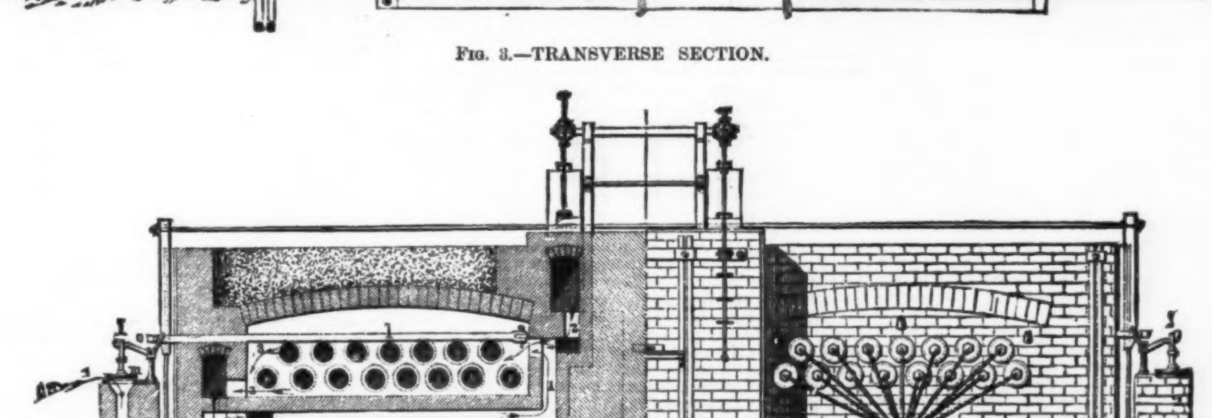


Fig. 4.—FURNACE. LONGITUDINAL SECTION. EXTERNAL VIEW.

THE MANUFACTURE OF OXYGEN FROM ATMOSPHERIC AIR.

A NEW LIGHTHOUSE AT MARSEILLES.

A new lighthouse, in which the electric light is to be used, has lately been completed at Marseilles The cost of the light is seven times less than the cost of that which it will replace. The new lighthouse will be one of the finest on the French coasts. The light, which will be equal to 3,500 gas jets, will be visible at a distance of twenty-seven miles.

NOTES ON GUMS, RESINS, AND WAXES.

By C. G. Warnford Lock.

The following economic notes from the journals of recent travelers seem worthy of reproduction in a collective form:

Senegal Gum.—The product of acacias which grow in the neighborhood of the Sahara. During the harmattan winds, the gum exudes from the bark of the trees in tears, and solidifies in the open air, the amount of exudation depending upon the force and duration of the wind. The production in 1871 was 3,161,906 kilos (of 2·2 lb.).

Mpafu.—A large tree yielding a sweet-scented gum-resin much valued by the natives on the Victoria Nyanza.

Gum Arabic is produced by *Acacia gummifera* (*Mimosa gummifera, Acacia coronillæfolia, Mimosa coronillæfolia, Sasas gummifera*), a scarcely known plant of Morocco, occurring abundantly as a thorny bush in the lower region of South and West Morocco, according to the testimony of the natives, who call the plant *alk tlah*. The gum does not seem to be collected in the western portion of its range in South Morocco, but in Demnet, whence it is carried to Mogador. Possibly it is only in the hotter and drier regions of the interior that the gum is produced in quantities to be worth gathering. At any rate, its gum is yielded only during the hot, parching months of July and August, and increases according to the hotness of the weather and the sickly appearance of the tree, being least after a wet winter and in a mild summer.

Some accounts suppose the Moroccan gum Arabic to be derived from *Acacia arabica*, which is found in Senegal; but all the inquiries made by Consul R. Drummond Hay, for Hooker & Ball, agree that this plant, the *alk awarwhal* of the Arabs, is not found in Sus, no such tree existing either north or south of the Atlas Mountains, its gum being brought from Soudan, and of inferior quality to that of *A. gummifera*. It is further stated that this latter species grows chiefly in the provinces of Blad Hamar, Rahamma, and Sus.

Elemi.—This used to be brought in large cakes to Bembe, (West Africa), and is said to be very abundant at not many days' journey.

Jutahy seca.—A resin or gum which exudes from the bark of the jutahy tree of Brazil (*Hymenæa mirabilis*); universally employed for varnishing native pottery.

Copal.—Red gum copal is almost entirely the product of the Mossulo country (Angola), though it exists farther north, as at Mangue Grande. Until 1858, it was a principal export from Ambriz to America, but the war stopped it. According to native accounts, it is found below the surface of a highly ferruginous hard clay, at a depth of a few inches to two feet. It probably extends much deeper, but the natives are too lazy to look for it. It occurs in irregular flat masses up to several pounds. The natives only dig for it during and after the last and heaviest rains in March to May, and restrict the export to maintain the price. No trees and but little grass grows over the spots. The tree is said to be abundant in the woods adjoining the inner side of the wilderness in Usambara (East Africa), but does not extend farther inland.

A great staple of the district traversed by the newly-made road from Dar es-Salaam, through the Wazamaro country, is gum copal, which is found in many parts. This fossil resin seems to exist, even in the richest diggings, only in patches, as though it were produced by isolated trees. The natives appear to work the country nowhere systematically; they sink test-holes, and, on finding traces of the resin, work that part thoroughly. In many places test-holes have been made and the place abandoned as useless, although not far off a patch has been well worked. The fossil resin, now found underground usually in red sandy soil, is undoubtedly the produce of the same species of tree as still exists in these jungles, and which now yields an inferior sort of resin. The difference between the two products seems to arise from chemical or molecular change effected by time. The copal tree grows throughout the Uzamaro country, and is by no means confined to the sea coast, but is even more abundant inland beyond the first coast-ridge. It is not seen, however, where the old limestone formation of the interior makes its appearance.

Chian Mastic.—The mastic country of Chios is usually flat and stony, with little hills intervening, and with rare streams. Rain is destructive of the harvest; frost is rare, but much to be feared. The resin is a product of *Pistachia lentiscus*. The principal villages engaged in the industry are Calimassia, St. Georges (south of Anabato), Nénita, Mesta, and Kalamoti, besides which there are about a dozen of minor importance. The mastic occurs in white grains, varying in size from a pin's head to a pea. The shrubs yielding it are about the height of a man. It occurs also in Africa and Arabia, but always of inferior quality, though no satisfactory reason has yet been adduced for the fact. In July to August a great number of incisions are made in the stems of the shrubs, and renewed three or four times. Repeated visits are then made to collect the resin which exudes. A shower of rain during this period produces disastrous results, by washing away the resin. There are four qualities of mastic: (1.) Cake mastic is composed of large pieces, and is considered the best by connoisseurs; it is sold chiefly for use in the seraglios—all Turkish women chewing mastic; its price is 120 to 130 piasters, and even more, per oke of 1,300 grm. (2.) Mastic in large tears is worth 90 to 100 piasters ordinarily. (3.) Mastic in small tears or pearls is worth 70 to 85 piasters, and is used industrially. (4.) Mastic mixed with fragments of leaves and sand is used to make so-called "mastic brandy," the well-known Turkish liqueur, called *raki*. It is made by digesting mastic in the brandy obtained from dry grapes, redistilling the product, and flavoring with anise seed and sugar. The best qualities of mastic are used in the Levant; Europe imports the inferior grades for making varnish.

Chian Turpentine.—Afforded by *Pistachia terebinthus*. That which exudes from the shrub is very white and aromatic, but the quantity is very limited.

India-rubber (from *Ficus elastica*).—The collection of the rubber in Assam is conducted under rigid restrictions in the case of all trees growing in the timber reserves, but cannot be enforced on scattered trees. The Chárdwár rubber plantation has an area of 80 square miles. The exports from Lakhimpur in 1871 were 260¾ tons, value £8,340. Immense forests of these trees existed on both banks of the Subansiri River and on other streams, but the reckless treatment they received from native lessees of the forests caused their ruin. In 1876, the leasing of these forests ceased, but there is now little or no rubber left in the plains of the Lakhimpur district. The tree grows to heights of fifteen to thirty five feet, and its girth, when fit to be tapped is eighteen inches to six feet. A high yield for the first tapping of a tree is thirty-five to forty pounds of rubber. It is then allowed to remain untouched for three or four years, when another collection is made, but the yield is then much less. It is estimated that the forests of Cachar could yield upwards of 2,000 cwt. of rubber annually. It is stated that the trees yield most during the rains.

Of India-rubber, 20,000,000 pounds are annually exported from Pará (Brazil), chiefly derived from *Siphonia elastica*, but a few other species are admitted. The utmost yield from each tree is one gill. In the wet season, from February to July, the gum is weak, and the tapping is stopped. The trees will grow on the *terra firma* when planted, but their seeds naturally lodge in lowland swamps. Trees properly planted and cared for yield well in fifteen years. Brazil is being gradually cleared of its rubber; gatherers now go to the Tocantins, Madeira, Purus, and Rio Negro, and will soon clear there also. Straus's method of preparing rubber, instead of smoking, is to drop the milk into alum solution; it is stated to be superior, but is not adopted.

India-rubber plants grow on the slopes of the Cameroons Mountains (West Africa), but the people do not know their value. India-rubber trees abound on the river Djour, in the province of Bahr el Ghazal. The natives of the Marutse-Mabunda empire, on the Upper Zambesi, trade in India-rubber with the tribes to the west.

The *Landolphia* vine is known from Pangani inland all the way to Handei (in Usambara, East Africa), and at Magila the rubber is made into balls for export.

The giant creeper, *Landolphia*, grows chiefly on trees near rivers and streams in Angola and the Congo. Every part exudes a milky juice when cut or wounded, but this will not run into a vessel placed to catch it, as it dries so quickly as to form a ridge on the wound, which stops its further flow. The blacks collect it by making long cuts in the bark with a knife, and as the milky juice gushes out, it is wiped off continually with the fingers, and smeared on their arms, shoulders, and breast, till a thick covering is formed. This is peeled off their bodies and cut into small squares, which are then said to be boiled in water. From Ambriz the trade in this rubber quickly spread south to the river Quanza, where considerable quantities are exported.

Within twenty miles of the coast from Liawa and the Lindi estuary (Masasi and Rovuma, East Africa) the forest becomes almost entirely formed of India-rubber vines, affording an abundant supply of fine India-rubber, at present gathered only in a very desultory manner by the natives, who gash the plants, and collect the rubber as it issues in a liquid form, and dries hard after short exposure to the air. Rolled into orange-like balls, it is taken to Lindi, where what is worth seven to eight dollars fetches two dollars. The width of the belt is fifteen to twenty miles. On the Victoria Lake (Central Africa) are one or two kinds of tree which produce caoutchouc of good quality.

Dr. Kirk has just determined, with accuracy, the plant which yields the best East African India rubber, and has obtained seeds of the species for introduction into India. It occurs in great abundance along the newly made road from Dar-es-Salaam, in a west-southwesterly direction, for about one hundred miles toward the interior of East Africa, through the Wazamaro country; it is apparently but little affected, except in the immediate neighborhood of the villages, by the reckless mode of tapping employed. In many parts, a native can still collect three pounds of rubber daily. There are five species, but only one is considered worth tapping.

Rubbers and Guttas of Borneo and Sulu.—The Kadyans and their Murut neighbors collect a quantity of gutta percha and India-rubber in the surrounding forests. The gums are afterward manufactured into lumps or balls, and conveyed to Labuan for sale. The gutta is obtained from four or five species of the genus *Isonandra*, all large forest trees. The trees are felled and their bark is girdled or ringed at intervals of two feet, the milky juice or sap being caught in vessels formed of leaves or cocoa-nut shells. The crude juice is hardened into slabs or bricks by boiling, and is generally adulterated with twenty per cent. of scraped bark. Indeed it is said that the Chinese traders, who buy up the gutta from the gatherers, would refuse the pure article in preference for that containing bark, to which the red color is mainly due.

India-rubber in the northwest districts of Borneo is the produce of three species of climbers, known to the natives as *manoongan*, *manoongan putih*, and *manoongan manga*. Their stems have a length of from fifty two to one hundred feet, and a diameter rarely exceeding six inches; the bark is corrugated, and colored gray or reddish-brown. The leaves are oblong, green, and glossy; the flowers are borne in axillary clusters, and are succeeded by yellow fruits of the size of oranges, and containing seeds as large as beans, each inclosed in a section of apricot-colored fruit. These fruits have a delicious flavor, and are much prized by the natives. The stems of the India-rubber creepers are also cut down to facilitate the collection of the creamy sap, which is afterward coagulated into rough balls by the addition of nipa salt.

The fallen gutta trees lie about in all directions in the forest, and the rubber-yielding *Willughbeias* are also gradually, but none the less surely, being exterminated by the collectors in Borneo, as throughout the other islands, and on the Peninsula, where they likewise abound.

It was formerly thought that gutta percha was the produce of only one species of tree (*Isonandra gutta*), but that obtained from the Lawas district is formed of the mingled saps of at least five species, the juices of a *Ficus*, and of one or two species of *Artocarpeæ*, being not unfrequently added as adulterants. The Bornean *gutta soosoo*, or India-rubber, again, is the mixed saps of three species of *Willughbeia*, with the milks of two or three other plants surreptitiously introduced to increase the quantity.

The gutta trees are slow to attai[illegible] [illegible]rity, and are difficult to propagate except from see[illegible] [illegible]e *Willughbeias*, on the other hand, grow rapidly, and readily lend themselves to both vegetative and seminal methods of propagation; hence these are especially deserving of the attention of the Government of India, where they may reasonably be expected to thrive.

There are, doubtless, yet many thousand tons of rubber and gutta in the Bornean woods, but as the trees are killed by the collectors without any thought of replacing them, the source of the supply must recede constantly farther from the markets, and prices will rise in consequence. The demand for India-rubber from Borneo is of quite recent growth, yet in many districts the supply is already practically exhausted.

In Assam, Java, and Australia, rubber is afforded by *Ficus elastica*, which is cultivated for the purpose. There are many milk-yielding species of *Ficus* in the Bornean forests which, with careful experiment, may possibly be made to contribute remunerative quantities. The Malayan representatives of the bread-fruit family also deserve examination, as an excellent India-rubber is derived from *Castilloa elastica*, a South American plant of this order.

Lac.—Secreted by an insect (*Coccus lacca*), on the branches and twigs of certain jungle trees, principally *khusum* (*Schleichera trijuga*), *plas* (*Butea frondosa*), and *bier* (*Zizyphus jujuba*). The lac from the first is more esteemed than that from the others. To some extent, the lac is found occurring, so to speak, spontaneously, and is collected by forest tribes, and brought by them to the fairs and bazaars for sale. Where, however, there is a regular trade in stick-lac, propagation of the insect is steadily carried on by those who wish for a certain and abundant crop. This propagation is effected by tying small twigs on which are crowded the eggs or larvæ of the insect, to the branches of the above-named species of trees. These larvæ are technically called seed. The larvæ, shortly after sowing, spread themselves over the branches, and, taking up position, secrete around themselves a hard crust of lac, which gradually spreads till it nearly completes the circle round the twig. At the proper season, the twigs are broken off, and on arrival at the factory, are passed between rollers, which admit of any degree of approximation. The lac is thus crushed off, and is separated from the woody portion by screening. It is next placed in large tubs half full of water, and is washed by coolies, who, standing in the tubs, and holding on to a bar above by their hands, stamp and pivot about on the heels and toes, until after a succession of changes, the resulting liquor comes off clear. The lac having been dried, is placed in long cylindrical bags of cotton cloth of medium texture, and about ten feet long and two inches in diameter. These bags, when filled, are taken to an apartment where there are a number of open charcoal furnaces. An operator grasps one end of the bag in his left hand, and slowly revolves it in front of the fire; at the same time, an assistant, seated at the other end of the bag, twists it in the opposite direction. The roasting soon melts the lac in the bag, and the twisting causes it to exude and drop into troughs placed below, which are often only the leaves of *Agave americana*. When a sufficient quantity in a molten condition is ready in the trough, the operator takes it up in a wooden spoon, and places it on a wooden cylinder, some eight or ten inches in diameter, the upper half of which is covered with brass—in some places the freshly cut, smooth, cylindrical stem of the plantain is used for this purpose. The stand which supports the cylinder gives it a sloping direction away from the operator. Another assistant, generally a woman, now steps forward with a strip of *agave* in her hands, and with a rapid and dexterous draw of this, the lac is spread at once into a sheet of uniform thickness, which covers the upper portion of the cylinder. The operator now cuts off the upper edge with a pair of scissors, and the sheet is lifted up by the assistant, who waves it about for a moment or two in the air, till it becomes quite crisp. It is then held up to the light, and any impurities, technically "grit," are simply punched out of the brittle sheet by the finger. The sheets are laid one upon another, and, at the end of the day, the tale is taken, and the chief operator is paid accordingly, the assistant receiving fixed wages. The sheets are placed in packing-cases, and when subjected to pressure, break into numerous fragments. In the fresh state, the finest quality has a rich golden luster.

The dark-red liquor before referred to, as resulting from the washing, is strained, in order to remove all portions of woody fiber and other foreign materials. It is then passed into large vats, where it is allowed to settle; the sediment is subjected to various washings, and at last allowed to settle finally, the supernatant liquor being drawn off. The sediment, when of the proper consistency, is placed in presses, from which it is taken out in the form of hard, dark-purple cakes, with the manufacturer's trade-mark impressed upon them. This constitutes what is known as lac-dye. The dye which is thus separated from the lac by washing is said to be the body of the insect—not a separate secretion.

It might appear that some mechanical arrangement would be more efficacious and economical for washing and separating the lac from the dye, but human labor is so cheap that this is not the case. The daily pay of the women is 1d. to 1½d.; of the men, 1½d. to 2d. No evil effect on the feet of the stampers is to be observed. The great and sudden oscillations of price in the London market render this trade very risky, and the aniline dyes have well-nigh rung the knell of lac-dye in European industry.

In Assam, a small quantity is produced in the district of Darrang. In some districts, the insect is artificially reared on the *jhuri* tree (*Ficus cordifolia*).

Indian White Wax.—This is produced by the female of the *Ceroplastes ceriferus*, an insect allied to the *Pela* of the Chinese, whose product is so largly used for making candles for the Buddhist temples. The Indian insect deposits its wax in small masses upon the twigs and branches of several trees, but more particularly on the *arjun* (*Terminalia arjuna*); it does not appear to have ever been propagated, nor has the wild product been collected in quantity. Though an article of undoubted value, it would perhaps scarcely repay expenditure of European time and capital; but the natives might surely render its cultivation a very profitable undertaking. The wax is soluble, or nearly so, in boiling alcohol, also in benzine and ether, but only very slightly in turpentine and carbonic disulphide (CS_2). Its composition is $C_{12}H_{24}O$. It is found at many widely-distant points throughout Sirguja, and is abundant, and suitably situated for experimental cultivation on the *arjun* trees growing upon the embankment of the Purulia Lake.

The Gum Trade of Somali Land (East Africa).—The gum, or *habak*, always sold in grades, bears the name of *ankobib*. On sifting, it is always found mixed with a small quantity of other sorts which make weight in the balance; these are the *habak euddé* and the *habak follala*. The incense, or *luban*, sold in grades, takes the name of *beiho*. The *saphi*, or "triage," is divided into three qualities. The first, *fasous*; the second, *nagoud*; the third, *medjigel*. The *saphi*, or "triage," is made into *doukans*, when the arrivals are not too great, by women and children, who are paid about 6d. a day.

The myrrh has but one quality, but it is necessary to be on the guard against the admixture of false myrrh of the same color, but more powerful odor, which the Arabs call *addi*. It is easy to recognize this latter, which always appears oily.

The *maïdi*, called in Europe "gum elemi," is a kind of incense in large bleached tears. It presents the same grades as incense, and buyers aim especially at preserving the tears unbroken to heighten the value.

The *alet*, or *mourcoud*, is a gray gum, with an exquisite odor recalling that of ambergris.

The *addi*, or false myrrh, whose odoriferous wood is mixed with the wood of *djirmeh*, has an odor when burnt closely resembling that of "seraglio pastilles."

The *fallah-fallah* is a resinous bark, which is burnt to give off a peculiar odor, under the name of *habak droun*.

Statistics of the annual receipts of gums and incenses at the ports of the Medjourtine coast:

	Bohars.
Bender Ziyâda	250
Bender Gâsem	1,200
Abou Régabé } Bender Baad }	900
Borah	300
Gandala	500
Bender Khor	1,000
Ras Orbé	450
Meraya	1,500
Guersa	200
Guesli	400
Bender Felik	700
Atloûla	1,000
Total	8,200

The bohar is equal to 136 kilos, or, say, 8,200 bohars are about 1,200 tons; this increases to 2,000 tons in a good year.

Myrrh reaches two places only :

Bender Gasem	30 bohars.
Borah	3 "

Haffoûn, in 1877, received 25 bohars.

Magnificent incense trees, two to three feet in diameter, are found on the lofty mountains toward the north coast of Somali Land. Mareyeh, an important village, lying over thirty miles west of Cape Gardafui, has a large export of myrrh and incense.

Obeidh, the capital of Kordofan, is the center of a large trade in gum, which is collected in the woods by the women and children, and taken to their villages, where it is disposed of to petty itinerant traders, for ultimate dispatch to Europe.

Moroccan Gum Ammoniacum (which must not be confounded with the Persian product of *Dorema ammoniacum*, or *ushak*) is an object of commerce with Egypt and Arabia, where it is employed, as of old, in fumigating. The plant affording it is called *fashook* in Arabic, and has been hitherto referred to *Ferula orientalis*, or *F. tingitana;* but Ball & Hooker consider it decidedly an *Elæoselinum*, probably *E. humile*. Leared was told that this plant grows at a place two days from Mogador, on the Morocco road; but Hooker & Ball were assured that it is found nowhere along that route, nor nearer to it than El Araiche, a place lying north of Morocco city, which is confirmed by information gathered by R. Drummond Hay, to the effect that it occurs near Morocco, and chiefly around Tedla.

Gum Sandarac is a product of *Callitris quadrivalvis* (*Thuja articulata, Frenela fontanesii*), a tree indigenous to the mountains of North Africa, from the Atlantic to East Algeria, its eastern limit being undetermined. The resin, once a reputed medicine, is collected by the Moors, and exported from Mogador to Europe, where it is used in varnish making.

Euphorbium Gum is produced by *Euphorbia resinifera*, a tree confined to the interior of Morocco. The juice flows from incisions made with a knife, and hardens and drops off in September, the produce being abundant only once in four years. The people who collect the gum tie cloths over their mouths and nostrils, to exclude the small dusty particles, which provoke intense sneezing. The gum once had a wide medicinal use, but the trade in it is now rapidly declining, and its consumption is restricted to veterinary practice, and as an ingredient in a marine paint.—*Jour. Soc. of Arts.*

DRIED FOAM.

By Reuben Brooks, of Rockport, Mass.

The process of preparing gelatine in the form of dried foam consists in two essential steps: first, in subjecting a solution of gelatine in water to violent agitation, or to the action of air-currents under pressure, whereby air is mingled with the solution and it becomes foamy; and, second, in evaporating the water from or dehydrating the foam produced as aforesaid by subjecting it to the action of cold dry air. The procedure attendant upon the accomplishment of either of these two essential steps is not confined to the employment of any peculiar mechanical devices.

The first step, consisting in the introduction of air in a finely-comminuted state into a liquid solution of gelatine, may be accomplished in many ways. The solution may be subjected to stirring, beating, or any violent agitation which will mingle air with it and cause it to foam—a result due to its increased bulk, owing to the presence in physical combination of an infinite number of minute air-globules. In lieu of stirring, beating, or other agitation, the solution of gelatine may be subjected to the action of air-currents passed through it under pressure.

The second essential step of the process consists in subjecting the foam resulting from the treatment of the solution during the first step to the evaporating or dehydrating action of currents of cold dry air, whereby the water combined with the gelatine in solution is completely eliminated therefrom, leaving the pure gelatine in a very finely divided state. In this condition it may be compressed and packed for transportation as the necessities of the trade may demand.

In subjecting the gelatine foam to the action of dry air care should be taken not to burst or break the bubbles until the film of gelatine which incloses each minute subdivision of air is dehydrated and hardened. Therefore it will not do to allow air-currents of much strength to strike the foam, as they would cause it to collapse and resume its liquid form. The temperature of the air to the action of which the foam is subjected should be only low enough to chill the gelatine film of each bubble and assist it in retaining its shape until dehydrated.

It is obvious that by simply subjecting the foam to still

dry air the desired results would be effected, only more slowly than when the air is in motion.

Dried foam of gelatine thus prepared dissolves with great readiness in water.

At the completion of the process the gelatine is so completely dehydrated that it may be preserved unaltered for an indefinite period.

The presence of water in gelatine, as is well known, is always attended with danger, as it is then more readily decomposed, and chemical treatment to avoid such consequences renders it unfit for dietetic uses and greatly impairs its value in the arts.

One of the greatest difficulties in evaporating or dehydrating gelatine solutions lies in the fact that the gelatine is very sensitive to the changes in the temperature and hygroscopic condition of the atmosphere, and often large quantities are rendered valueless by such sudden and uncontrollable changes. My process of dehydration is entirely independent of atmospheric conditions, and they in no wise affect its successful prosecution.

The chemical purity of the product has already been adverted to. Of its physical purity it is only necessary to state that, as the process is very rapidly carried on, and as the solution is not exposed to such an extent as it is when the old methods of evaporation are employed, there is no opportunity for dust and foreign substances to become incorporated with the gelatine product.

While my process is adapted to be used in dehydrating all gelatine solutions, from whatever source they may be derived, it is peculiarly fitted to be employed in preparing for the market gelatine or ichthyocolla obtained from fish skins, salted or fresh, and also from other fish tissues.

In the instance of using salted fish skins in obtaining the gelatine solution from which to prepare dried foam the skins must be first passed through a desalting process, not necessary to be here described.

ON THE DETECTION OF LEAD IN POTABLE WATERS BY MEANS OF POTASSIUM BICHROMATE.*

By SIDNEY HARVEY.

THE dark color struck by hydrogen sulphide in samples of water suspected of metallic impregnation may be due to lead, copper, tin, and possibly other metals, and as the tone and intensity of tint produced by this reagent varies in the case of the three metals above named, it becomes important before attempting any colorimetric estimation by means of standard solutions to decide which metal is really present.

I have been in the habit for a considerable time past of employing bichromate of potash for the identification of lead, and consider it to be the most efficient and delicate test for the purpose as well as very simple and easy in the mode of application.

The following experiments have been undertaken to prove this:

Taken—Standard solution of lead acetate, strength 0·1 milligramme metal in 1 c.c.

Taken—Canterbury water works water.

Taken—Small crystals of potassium bichromate, potassium iodide, and sodium sulphate.

Phillips' precipitating jars were used in every case.

Experiment 1.—143 c.c. standard lead made up to one liter with the water and divided into three portions. Strength, one grain of metal per gallon.

Sodium Sulphate.—Solution still bright in twenty-four hours. A very slight and doubtful deposit at bottom of glass.

Potassium Iodide.—Incipient yellow scales in half an hour. A complete deposition in twelve hours of yellow plumbic iodide.

Potassium Bichromate.—Immediate and very dense turbidity, precipitating in six hours, covering bottom of glass and considerable in amount.

Experiment 2.—28·6 c.c. standard lead in one liter water (strength one-fifth of a grain in gallon).

Potassium Iodide.—Clear and colorless solution twenty-four hours after. Slight trace of scales of iodide at bottom, but hardly visible.

Potassium Bichromate.—Immediate and considerable turbidity, depositing precipitate in six hours.

Experiment 3.—14·3 c.c. standard lead in one liter water (strength, one-tenth of a grain per gallon).

Potassium Bichromate Crystals.—Very pronounced turbidity at once.

Experiment 4.—7·15 c.c. standard lead in one liter water (one-twentieth of a grain per gallon).

Potassium Bichromate Crystals.—Distinct turbidity in fifteen minutes.

Experiment 5.—3 c.c. standard lead in one liter water (one fiftieth of a grain per gallon).

Potassium Bichromate Crystals.—Distinct turbidity in thirty minutes.

In all cases the jars used were set alongside similar jars containing water free from lead and tested in same manner.

In every case where bichromate was used and sufficient time was allowed for subsidence, the colored water could be poured off to the last drop without disturbing the lead chromate, which latter could then be shaken with a little distilled water, and its color and properties better observed than when in a yellow fluid.

I consider it of great importance that the reagent should be added to the water in crystals and not in solution. The former is for some reason far more prompt and delicate in its effects.

I also find that for the production of lead iodide (a very characteristic precipitate by the way) a large quantity of potassium iodide is required for dilute solutions of lead.

Sulphates are no bar to the detection of lead in water by bichromate. 10 c.c. standard lead (= milligramme metal) were evaporated to dryness with sulphuric acid, heated to expel excess of latter. Residue moistened with dilute nitric acid, 5 c.c. water added, boiled, and a little sodium acetate added. A crystal of bichromate added to the cleared solution gave an immediate precipitate of lead chromate.

To conclude, about one-fourth liter of the water to be examined is brightened (if necessary) with a drop or two of acetic acid and agitated in a Phillips precipitating jar with a few minute crystals of potassium bichromate. Lead, if present in the proportion of one part in three and a half millions, will be detected by the yellow turbidity or precipitate produced.

* Lately read before the Society of Public Analysts.

VACCINATION OF ANIMALS.

REMARKABLE ADDRESS BY PROF. PASTEUR.

AT a general meeting of the members of the International Medical Congress, held in St. James' Hall, on August 8, an important address was delivered by Professor Pasteur, embodying the results of his most recent researches in animal vaccination. Sir James Paget occupied the chair.

Professor Pasteur spoke in French as follows: Gentlemen, I had no intention of addressing this admirable congress, which brings together the most eminent medical men in the world, and the great success of which does so much credit to its principal organizer, Dr. MacCormac. The goodwill of your esteemed president has decided otherwise. How could one, in fact, resist the sympathetic words of that eminent man whose goodness of heart is associated in no small degree with great oratorical ability? Two motives have brought me to London. The first was to gain instruction, to profit by your learned discussions; and the second was to ascertain the place now occupied in medicine and surgery by the germ theory. Certainly I shall return to Paris well satisfied. During the past week I have learned much. I carry away with me the conviction that the English people is a great people, and as for the influence of the new doctrine, I have been not only struck by the progress it has made, but by its triumph. I should be guilty of ingratitude and of false modesty if I did not accept the welcome I have received among you and in English society as a mark of homage paid to my labors during the past five-and-twenty years upon the nature of ferments—their life and their nutrition, their preparation in a pure state by the introduction of organisms (*ensemencement*) under natural and artificial conditions—labors which have established the principles and the methods of *microbie* (microbism), if the expression is allowable. Your cordial welcome has revived within me the lively feeling of satisfaction I experienced when your great surgeon Lister declared that my publication in 1857 on milk fermentation had inspired him with his first ideas on his valuable surgical method. You have reawakened the pleasure I felt when our eminent physician Dr. Davaine declared that his labors upon *charbon* (splenic fever or malignant pustules) had been suggested by my studies on butyric fermentation and the vibrion which is characteristic of it. (Loud cheers.) Gentlemen, I am happy to be able to thank you by bringing to your notice a new advance in the study of *microbie* as applied to the prevention of transmissible diseases—diseases which for the most part are fraught with terrible consequences, both for man and domestic animals. The subject of my communication is vaccination in relation to chicken cholera and splenic fever, and a statement of the method by which we have arrived at these results—a method the fruitfulness of which inspires me with boundless anticipations. Before discussing the question of splenic fever vaccine, which is the most important, permit me to recall the results of my investigations of chicken cholera. It is through this inquiry that new and highly important principles have been introduced into science concerning the virus or contagious quality of transmissible diseases. More than once in what I am about to say I shall employ the expression virus-culture, as formerly, in my investigations on fermentation, I used the expressions, the culture of milk ferment, the culture of the butyric vibrion, etc. Let us take, then, a fowl which is about to die of chicken cholera, and let us dip the end of a delicate glass rod in the blood of the fowl with the usual precautions, upon which I need not here dwell. Let us then touch with this charged point some *bouillon de poule*, very clear, but first of all rendered sterile under a temperature of about 115 degrees centigrade, and under conditions in which neither the outer air nor the vases employed can introduce exterior germs—those germs which are in the air or on the surface of all objects. In a short time, if the little culture vase is placed in a temperature of 25 degrees to 35 degrees, you will see the liquid become turbid and full of tiny microbes, shaped like the figure 8, but often so small that under a high magnifying power they appear like points. Take from this vase a drop as small as you please, no more than can be carried on the point of a glass rod as sharp as a needle, and touch with this point a fresh quantity of sterilized *bouillon de poule* placed in a second vase, and the same phenomenon is produced.

You deal in the same way with a third culture vase, with a fourth, and so on to a hundred or even a thousand, and invariably within a few hours the culture liquid becomes turbid and filled with the same minute organisms. At the end of two or three days' exposure to a temperature of about 30 degrees C., the thickness of the liquid disappears and a sediment is formed at the bottom of the vase. This signifies that the development of the minute organism has ceased—in other words, all the little points which caused the turbid appearance of the liquid have fallen to the bottom of the vase, and things will remain in this condition for a longer or shorter time, for months even, without either the liquid or the deposit undergoing any visible modification, inasmuch as we have taken care to exclude the germs of the atmosphere. A little stopper of cotton sifts the air which enters or issues from the vase through changes of temperature.

Let us take one of our series of culture preparations—the hundredth or the thousandth, for instance, and compare it in respect to its virulence with the blood of a fowl which has died of cholera; in other words, let us inoculate under the skin ten fowls, for instance, each separately with a tiny drop of infectious blood, and the ten others with a similar quantity of the liquid in which the deposit has first been shaken up. Strange to say the latter ten fowls will die as quickly and with the same symptoms as the former ten; the blood of all will be found to contain after death the same minute infectious organisms. This equality, so to speak, in the virulence both of the culture preparation and of the blood is due to an apparently futile circumstance. I have made a hundred culture preparations; at least, I have understood that this was done—without leaving any considerable interval between the impregnations. Well, here we have the cause of the equality in the virulence. Let us now repeat exactly our successive cultures with this single difference, that we pass from one culture to that which follows it, from the hundredth to, say, the hundred and first, at intervals of a fortnight, a month, two months, three months, or ten months. If, now, we compare the virulence of the successive cultures, a great change will be observed.

It will be readily seen from an inoculation of a series of ten fowls that the virulence of one culture differs from that of the blood and from that of a preceding culture when a sufficiently long interval elapses between the impregnation of one culture with the microbe of the preceding. More than that, we may recognize by this mode of observation that it is possible to prepare cultures of varying degrees of virulence. One preparation will kill eight fowls out of ten, another five out of ten, another one out of ten, another none at all, although the microbe may still be cultivated. In fact, what is no less strange, if you take each of these cultures of attenuated virulence as a point of departure in the preparation of successive cultures and without appreciable interval in the impregnation, the whole series of these cultures will reproduce the attenuated virulence of that which has served as the starting point. Similarly, where the virulence is null it produces no effect. How, then, it may be asked, are the effects of these attenuated virulences revealed in the fowls? They are revealed by a local disorder, by a morbid modification more or less profound in a muscle, if it is a muscle which has been inoculated with the virus. The muscle is filled with microbes which are easily recognized because the attenuated microbes have almost the bulk, the form, and the appearance of the most virulent microbes. But why is not the local disorder followed by death? For the moment let us answer by a statement of facts. They are these: the local disorder ceases of itself more or less speedily, the microbe is absorbed and digested, if one may say so, and little by little the muscle regains its normal condition. Then the disease has disappeared. When we inoculate with the microbe the virulence of which is null, there is not even local disorder, the *natura medicatrix* carries it off at once, and here, indeed, we see the influence of the resistance of life, since this microbe the virulence of which is null multiplies itself. A little further, and we touch the principle of vaccination. When the fowls have been rendered sufficiently ill by the attenuated virus which the vital resistance has arrested in its development, they will, when inoculated with virulent virus, suffer no evil effects, or only effects of a passing character. In fact, they no longer die from the mortal virus, and for a time sufficiently long, which in some cases may exceed a year, chicken cholera cannot touch them, especially under the ordinary conditions of contagion which exist in fowl-houses.

At this critical point of our manipulation—that is to say, in this interval of time which we have placed between two cultures, and which causes the attenuation, what occurs? I shall show you that in this interval the agent which intervenes is the oxygen of the air. Nothing more easily admits of proof. Let us produce a culture in a tube containing very little air, and close this tube with an enameler's lamp. The microbe in developing itself will speedily take all the oxygen of the tube and of the liquid, after which it will be perfectly free from contact with oxygen. In this case it does not appear that the microbe becomes appreciably attenuated, even after a great lapse of time. The oxygen of the air, then, would seem to be a possible modifying agent of the virulence of the microbe of chicken cholera, that is to say, it may modify more or less the facility of its development in the body of animals. May we not be here in presence of a general law applicable to all kinds of virus? What benefits may not be the result? (Cheers.) We may hope to discover in this way the vaccine of all virulent diseases; and what is more natural than to begin our investigation of the vaccine of what we in French call *charbon*, what you in England call splenic fever, and what in Russia is known as the Siberian pest, and in Germany as the *Milzbrand*?

In this new investigation I have had the assistance of two devoted young *savants*, MM. Chamberland and Roux. At the outset we were met by a difficulty. Among the inferior organisms all do not resolve themselves into those corpuscle germs which I was the first to point out as one of the forms of their possible development. Many infectious microbes do not resolve themselves in their cultures into corpuscle germs. Such is equally the case with beer yeast, which we do not see develop itself usually in breweries, for instance, except by a sort of scissiparity. One cell makes two or more which form themselves in wreaths; the cells become detached, and the process recommences. In these cells real germs are not usually seen. The microbe of chicken cholera and many others behave in this way, so much so that the cultures of this microbe, although they may last for months without losing their power of fresh cultivation, perish finally like beer yeast which has exhausted all its aliments. The anthracoid microbe in artificial cultures behaves very differently. In the blood of animals, as in cultures, it is found in translucid filaments more or less segmented. This blood or these cultures, freely exposed to air, instead of continuing according to the first mode of generation, show at the end of forty-eight hours corpuscle germs distributed in series more or less regular along the filaments. All around those corpuscles matter is absorbed, as I have represented it formerly in one of the plates of my work on the diseases of silkworms. Little by little all connection between them disappears, and presently they are reduced to nothing more than germ dust. If you make these corpuscles germinate, the new culture reproduces the virulence peculiar to the thready form which has produced these corpuscles, and this result is seen even after a long exposure of these germs to contact with air. Recently we discovered them in pits in which animals dead of splenic fever had been buried for twelve years, and their culture was as virulent as that from the blood of an animal recently dead.

Here I regret extremely to be obliged to shorten my remarks. I should have had much pleasure in demonstrating that the anthracoid germs in the earth of pits in which animals have been buried are brought to the surface by earthworms, and that in this fact we may find the whole etiology of disease, inasmuch as the animals swallow these germs with their food. A great difficulty presents itself when we attempt to apply our method of attenuation by the oxygen of the air to the anthracoid microbes. The virulence establishing itself very quickly, often after four-and-twenty hours in an anthracoid germ which escapes the action of the air, it was impossible to think of discovering the vaccine of splenic fever in the conditions which had yielded that of chicken cholera; but was there after all reason to be discouraged? Certainly not. In fact, if you observe closely you will find that there is no real difference between the mode of the generation of the anthracoid germ by scission and that of chicken cholera. We had therefore reason to hope that we might overcome the difficulty which stopped us by endeavoring to prevent the anthracoid microbe from producing corpuscle germs and to keep it in this condition in contact with oxygen for days, and weeks, and months. The experiment fortunately succeeded. In the ineffective (*neutre*) *bouillon de poule* the anthracoid microbe is no longer cultivatable at 45 degrees C. Its culture, however, is easy at 42 degrees or 43 degrees, but in these conditions the microbe yields no spores. Consequently it is possible to maintain in contact with the pure air at 42 degrees or 43 degrees, a *mycelienne* culture of *bacterides* entirely free of germs. Then appear the very remarkable results which follow. In a month or six weeks the culture dies. That is to say, if one impregnates with it fresh *bouillon*, the latter is completely sterile. Up till that time life exists in the vase exposed to air and heat. If we examine the virulence of the culture at the end of two days, four days, six days, eight days, etc., it will be found that long before the death of the

culture the microbe has lost all virulence, although still cultivable. Before this period it is found that the culture presents a series of attenuated virulences. Everything is similar to what happens in respect to the microbe in chicken cholera. Besides, each of these conditions of attenuated virulence may be reproduced by culture; in fact, since the *charbon* does not operate a second time (*ne récidive pas*), each of our attenuated anthracoid microbes constitutes for the superior microbe a vaccine—that is to say, a virus capable of producing a milder disease. Here, then, we have a method of preparing the vaccine of splenic fever.

You will see presently the practical importance of this result, but what interests us more particularly is to observe that we have here a proof that we are in possession of a general method of preparing virus vaccine based upon the action of the oxygen and the air—that is to say, of a cosmic force existing everywhere on the surface of the globe.

I regret to be unable from want of time to show you that all these attenuated forms of virus may very easily, by a physiological artifice, be made to recover their original *maximum* virulence. The method I have just explained of obtaining the vaccine of splenic fever was no sooner made known than it was very extensively employed to prevent the splenic affection. In France we lose every year by splenic fever animals of the value of 20,000,000f.

I was asked to give a public demonstration of the results already mentioned. This experiment I may relate in a few words. Fifty sheep were placed at my disposition, of which twenty-five were vaccinated. A fortnight afterward the fifty sheep were inoculated with the most virulent anthracoid microbe. The twenty-five vaccinated sheep resisted the infection; the twenty-five unvaccinated died of splenic fever within fifty hours. Since that time my energies have been taxed to meet the demands of farmers for supplies of this vaccine. In the space of fifteen days we have vaccinated in the departments surrounding Paris more than 20,000 sheep and a large number of cattle and horses. (Loud cheers.)

If I were not pressed for time I should bring to your notice two other kinds of virus attenuated by similar means. These experiments will be communicated by and by to the public. I cannot conclude, gentlemen, without expressing the great pleasure I feel at the thought that it is as a member of an international medical congress assembled in England that I make known the most recent results of vaccination upon a disease more terrible, perhaps, for domestic animals than smallpox is for man. I have given to vaccination an extension which science, I hope, will accept as a homage paid to the merit and to the immense services rendered by one of the greatest men of England—Jenner. (Cheers.) What a pleasure for me to do honor to this immortal name in this noble and hospitable city of London! (Loud cheers.)

THE CONNECTION OF THE BIOLOGICAL SCIENCES WITH MEDICINE.

By PROFESSOR HUXLEY.

THE concluding meeting of the International Medical Congress was held on August 9, in St. James's Hall, London, Sir James Paget in the chair, when a general address was delivered by Professor Huxley on the connection of the biological sciences with medicine.

The great body of theoretical and practical knowledge, said Professor Huxley, which has been accumulated by the labors of some eighty generations, since the dawn of scientific thought in Europe, has no collective English name to which an objection may not be raised, and I use the term "medicine" as that which is least likely to be misunderstood; though, as every one knows, the name is commonly applied, in a narrower sense, to one of the cheap divisions of the totality of medical science. Taken in this broad sense, "medicine" not merely denotes a kind of knowledge, but it comprehends the various applications of that knowledge to the alleviation of the sufferings, the repair of the injuries, and the conservation of the health of living beings. In fact, the practical aspect of medicine so far dominates over every other that the "healing art" is one of its most widely-achieved synonyms. It is so difficult to think of medicine otherwise than as something which is necessarily connected with curative treatment that we are apt to forget that there must be and is such a thing as a pure science of medicine—a "pathology" which has no more necessary subservience to practical ends than has zoology or botany. The logical connection between this purely scientific doctrine of disease or pathology and ordinary biology is easily traced. Living matter is characterized by its innate tendency to exhibit a definite series of the morphological and physiological phenomena which constitute organization and life. Given a certain range of conditions, and these phenomena remain the same within narrow limits, for each kind of living thing. They furnish the normal and typical characters of the species, and, as such, they are the subject-matter of ordinary biology. Outside the range of these conditions the normal course of the cycle of vital phenomena is disturbed, abnormal structure makes its appearance, or the proper character and mutual adjustment of the functions cease to be preserved. The extent and the importance of these deviations from the typical life may vary indefinitely. They may have no noticeable influence on the general wellbeing of the economy or they may favor it. On the other hand, they may be of such a nature as to impede the activities of the organism or even to involve its destruction.

In the first case, these perturbations are ranged under the wide and somewhat vague category of "variations;" in the second, they are called lesions, states of poisoning, or diseases; and, as morbid states, they lie within the province of pathology. No sharp line of demarkation can be drawn between the two classes of phenomena. No one can say where anatomical variations end and tumors begin, nor where modification of function, which may at first promote health, passes into disease. All that can be said is that whatever change of structure or function is hurtful belongs to pathology. Hence it is obvious that pathology is a branch of biology; it is the morphology, the physiology, the distribution, the etiology of abnormal life. However obvious this conclusion may be now, it was nowise apparent in the infancy of medicine. For it is a peculiarity of the physical sciences that they are independent in proportion as they are imperfect; and it is only as they advance that the bonds which really unite them all become apparent.

Astronomy had no manifest connection with terrestrial physics before the publication of the "Principia;" that of chemistry with physics is of still more modern revelation; that of physics and chemistry, with physiology, has been stoutly denied within the recollection of most of us, and perhaps still may be. Or, to take a case which affords a closer parallel with that of medicine. Agriculture has been cultivated from the earliest times, and from a remote antiquity men have attained considerable practical skill in the cultivation of the useful plants, and have empirically established many scientific truths concerning the conditions under which they flourish. But it is within the memory of many of us that chemistry on the one hand, and vegetable physiology on the other, attained a stage of development such that they were able to furnish a sound basis for scientific agriculture. Similarly medicine took its rise in the practical needs of mankind. At first, studied without reference to any other branch of knowledge, it long maintained—indeed, still to some extent maintains—that independence. Historically, its connection with the biological sciences has been slowly established, and the full extent and intimacy of that connection are only now beginning to be apparent.

I trust I have not been mistaken in supposing that an attempt to give a brief sketch of the steps by which a philosophical necessity has become a historical reality may not be devoid of interest, possibly of instruction, to the members of this great congress, profoundly interested as all are in the scientific development of medicine. The history of medicine is more complete and fuller than that of any other science, except, perhaps, astronomy; and if we follow back the long record as far as clear evidence lights us, we find ourselves taken to the early stages of the civilization of Greece. The oldest hospitals were the temples of Æsculapius; to these Asclepeia, always erected on healthy sites, hard by fresh springs and surrounded by shady groves, the sick and the maimed resorted to seek the aid of the god of health. Votive tablets or inscriptions recorded the symptoms no less than the gratitude of those who were healed, and from these primitive clinical records the half-priestly, half-philosophic caste of the Asclepiads compiled the data upon which the earliest generalizations of medicine, as an inductive science, were based. In this state, pathology, like all the inductive sciences at their origin, was merely natural history; it registered the phenomena of disease, classified them, and ventured upon a prognosis wherever the observation of constant coexistences and sequences suggested a rational expectation of the like recurrence under similar circumstances. Further than this it hardly went. In fact, in the then state of knowledge and in the condition of philosophical speculation at that time, neither the causes of the morbid state nor the *rationale* of treatment was likely to be sought for as we seek for them now. The anger of a god was a sufficient reason for the existence of a malady, and a dream ample warranty for therapeutic measures; that a physical phenomenon must needs have a physical cause was not the implied or expressed axiom that it is to us moderns. The great man whose name is inseparably connected with the foundation of medicine, Hippocrates, certainly knew very little, indeed practically nothing, of anatomy or physiology; and he would probably have been perplexed even to imagine the possibility of a connection between the zoological studies of his contemporary Democritus and medicine. Nevertheless, in so far as he and those who worked before and after him in the same spirit ascertained, as matters of experience, that a wound or a luxation, or a fever, presented such and such symptoms, and that the return of the patient to health was facilitated by such and such measures, they established laws of nature and began the construction of the science of pathology.

All true science begins with empiricism, though all true science is such exactly in so far as it strives to pass out of the empirical stage into that of the deduction of empirical from more general truths. Thus, it is not wonderful that the early physicians had little or nothing to do with the development of biological science; and, on the other hand, that the early biologists did not much concern themselves with medicine. There is nothing to show that the Asclepiads took any prominent share in the work of founding anatomy, physiology, zoology, and botany. Rather do these seem to have sprung from the early philosophers, who were essentially natural philosophers, animated by the characteristically Greek thirst for knowledge as such. Pythagoras, Alcmeon, Democritus, Diogenes of Apollonia, are all credited with anatomical and physiological investigation; and though Aristotle is said to have belonged to an Asclepiad family, and not improbably owed his taste for anatomical and zoological inquiries to the teachings of his father, the physician Nicomachus, the "Historia Animalium" and the treatise "De Partibus Animalium" are as free from any allusion to medicine as if they had issued from a modern biological laboratory. It may be added that it is not easy to see in what way it could have benefited a physician of Alexander's time to know all that Aristotle knew on these subjects. His human anatomy was too rough to avail much in diagnosis; his physiology was too erroneous to supply *data* for pathological reasoning. But when the Alexandrian school, with Erasistratus and Herophilus at their head, turned to account the opportunities of studying human structure afforded to them by the Ptolemies, the value of the large amount of accurate knowledge thus obtained to the surgeon for his operations and to the physician for his diagnosis of internal disorders became obvious, and a connection was established between anatomy and medicine which has ever become closer and closer. Since the revival of learning, surgery, medical diagnosis, and anatomy have gone hand in hand. Morgagni called his great work, "De sedibus et causis morborum per anatomen indagatis," and not only showed the way to search out the localities and the causes of disease by anatomy, but himself traveled wonderfully far upon the road. Bichat, discriminating the grosser constituents of the organs and parts of the body one from another, pointed out the direction which modern research must take; until, at length, histology, a science of yesterday, as it seems to many of us, has carried the work of Morgagni as far as the microscope can take us, and has extended the realm of pathological anatomy to the limits of the invisible world. Thanks to the intimate alliance of morphology with medicine, the natural history of disease has at the present day attained a high degree of perfection. Accurate regional anatomy has rendered practicable the exploration of the most hidden parts of the organism and the determination during life of morbid changes in them; anatomical and histological *post mortem* investigations have supplied physicians with a clear basis upon which to rest the classification of diseases, and with unerring tests of the accuracy or inaccuracy of their diagnoses. If men could be satisfied with pure knowledge, the extreme precision with which, in these days, a sufferer may be told what is happening and what is likely to happen, even in the most recondite parts of his bodily frame, should be as satisfactory to the patient as it is to the scientific pathologist who gives him the information. But I am afraid it is not; and even the practicing physician, while nowise underestimating the regulative value of accurate diagnosis, must often lament that so much of his knowledge rather prevents him from doing wrong than helps him to do right. A scorner of physic once said that nature and disease may be compared to two men fighting, the doctor to a blind man with a club, who strikes into the *mêlée*, sometimes hitting the disease and sometimes hitting nature. The matter is not mended if you suppose the blind man's hearing to be so acute that he can register every stage of the struggle and pretty clearly predict how it will end. He had better not meddle at all until his eyes are opened—until he can see the exact position of the antagonists, and make sure of the effect of his blows. But that which it behooves the physician to see, not, indeed, with his bodily eye, but with clear intellectual vision, is a process, and the chain of causation involved in that process. Disease, as we have seen, is a perturbation of the normal activities of a living body, and it is, and must remain, unintelligible, so long as we are ignorant of the nature of these normal activities. In other words, there could be no real science of pathology until the science of physiology had reached a degree of perfection unattained, and, indeed, unattainable, until quite recent times. So far as medicine is concerned, I am not sure that physiology, such as it was down to the time of Harvey, might as well not have existed. Nay, it is perhaps no exaggeration to say that within the memory of living men, justly renowned practitioners of medicine and surgery knew less physiology than is now to be learnt from the most elementary text book; and, beyond a few broad facts, regarded what they did know as of extremely little practical importance. Nor am I disposed to blame them for this conclusion; physiology must be useless, or worse than useless, to pathology, so long as its fundamental conceptions are erroneous. Harvey is often said to be the founder of modern physiology, and there can be no question that the elucidations of the function of the heart, of the nature of the pulse, and of the course of the blood, put forth in the ever-memorable little essay, "De motu cordis," directly worked a revolution in men's views of the nature and of the concatenation of some of the most important physiological processes among the higher animals; while indirectly their influence was perhaps even more remarkable. But, though Harvey made this signal and perennially important contribution to the physiology of the moderns, his general conception of vital processes was essentially identical with that of the ancients; and, in the "Exercitationes de Generatione," and notably in the singular chapter "De Calido Innato," he shows himself a true son of Galen and Aristotle. For Harvey, the blood possesses powers superior to those of the elements; it is the seat of a soul which is not only vegetative, but also sensitive and motor. The blood maintains and fashions all parts of the body, "idque summa cum providentia et intellectu, in finem certum agens, quasi ratiocinio quodam uteretur." Here is the doctrine of the "pneuma," the product of the philosophical mould into which the animism of primitive men ran in Greece, in full force. Nor did its strength abate for long after Harvey's time. The same ingrained tendency of the human mind to suppose that a process is explained when it is ascribed to a power of which nothing is known, except that it is the hypothetical agent of the process, gave rise in the next century to the animism of Stahl; and, later, to the doctrine of a vital principle, that "asylum ignorantiæ" of physiologists which has so easily accounted for everything and explained nothing down to our own times. Now the essence of modern, as contrasted with ancient, physiological science appears to me to lie in its antagonism to animistic hypotheses and animistic phraseology. It offers physical explanations of vital phenomena, or frankly confesses that it has none to offer. And, so far as I know, the first person who gave expression to this modern view of physiology, who was bold enough to enunciate the proposition that vital phenomena, like all the other phenomena of the physical world, are, in ultimate analysis, resolvable into matter and motion, was René Descartes. The 54 years of life of this most original and powerful thinker are widely overlapped on both sides by the 80 of Harvey, who survived his younger contemporary by seven years, and takes pleasure in acknowledging the French philosopher's appreciation of his great discovery. In fact, Descartes accepted the doctrine of the circulation as propounded by "Hervæus, médecin d'Angleterre," and gave a full account of it in his first work, the famous "Discours de la Méthode," which was published in 1637, only nine years after the exercitation "De motu cordis;" and though differing from Harvey in some important points (in which, it may be noted in passing, Descartes was wrong and Harvey right), he always speaks of him with great respect. And so important does the subject seem to Descartes that he returns to it in the "Traité des Passions" and in the "Traité de l'Homme." It is easy to see that Harvey's work must have had a very peculiar significance for the subtle thinker to whom we owe both the spiritualistic and the materialistic philosophies of modern times. It was in the very year of its publication, 1628, that Descartes withdrew into that life of solitary investigation and meditation of which his philosophy was the fruit. And, as the course of his speculations led him to establish an absolute distinction of nature between the material and the mental world, he was logically compelled to seek for the explanation of the phenomena of the material world within itself, and, having allotted the realm of thought to the soul, to see nothing but extension and motion in the rest of nature. Descartes uses "thought" as the equivalent of our modern term "consciousness." Thought is the function of the soul, and its only function. Our natural heat and all the movements of the body, he says, do not depend on the soul. Death does not take place from any fault of the soul, but only because the principal parts of the body become corrupted. The body of a living man differs from that of a dead man in the same way as a watch or other automaton (that is to say, a machine which moves of itself), when it is wound up and has in itself the physical principle of the movements which the mechanism is adapted to perform, differs from the same watch or other machine when it is broken, and the physical principle of its movement no longer exists. All the actions which are common to us and the lower animals depend only on the conformation of our organs and the course which the animal spirits take in the brain, the nerves, and the muscle; in the same way as the movement of a watch is produced by nothing but the force of its spring and the figure of its wheels and other parts. Descartes's treatise on man is a sketch of human physiology in which a bold attempt is made to explain all the phenomena of life, except those of consciousness, by physical reasonings. To a mind turned in this direction, Harvey's exposition of the heart and vessels as a hydraulic mechanism must have been supremely welcome. Descartes was not a mere philosophical theorist, but a hard-working dissector and experimenter, and he held the strongest opinion respecting the practical value of the new conception which he was introducing. He speaks of the importance of preserving health, and of the dependence of the mind on the body being so close that perhaps the only way of making men wiser and better than they are is to be

sought in medical science. "It is true," he says, "that as medicine is now practiced, it contains little that is very useful; but, without any desire to depreciate, I am sure that there is no one, even among professional men, who will not declare that all we know is very little as compared with that which remains to be known; and that we might escape an infinity of diseases of the mind, no less than of the body, and even perhaps from the weakness of old age, if we had a sufficient knowledge of their causes, and of all the remedies with which nature has provided us." So strongly impressed was Descartes with this that he resolved to spend the rest of his life in trying to acquire such a knowledge of nature as would lead to the construction of a better medical doctrine. The anti-Cartesians found material for cheap ridicule in these aspirations of the philosopher; and it is almost needless to say that in the 13 years which elapsed between the publication of the "Discours" and the death of Descartes he did not contribute much to their realization. But, for the next century, all progress in physiology took place along the lines which Descartes laid down. The greatest physiological and pathological work of the 17th century, Borelli's treatise "De Motu Animalium," is, to all intents and purposes, a development of Descartes's fundamental conception; and the same may be said of the physiology and pathology of Boerhaave, whose authority dominated in the medical world of the first half of the 18th century. With the origin of modern chemistry, and of electrical science, in the latter half of the 18th century, aids in the analysis of the phenomena of life, of which Descartes could not have dreamed, were offered to the physiologist. And the greater part of the gigantic progress which has been made in the present century is a justification of the prevision of Descartes. For it consists, essentially, in a more and more complete resolution of the grosser organs of the living body into physico-chemical mechanisms. "I shall try to explain our whole bodily machinery in such a way that it will be no more necessary for us to suppose that the soul produces such movements as are not voluntary than it is to think that there is in a clock a soul which causes it to show the hours." These words of Descartes might be appropriately taken as a motto by the author of any modern treatise on physiology. But though, as I think, there is no doubt that Descartes was the first to propound the fundamental conception of the living body as a physical mechanism, which is the distinctive feature of modern as contrasted with ancient physiology, he was misled by the natural temptation to carry out, in all its details, a parallel between the machines with which he was familiar, such as clocks and pieces of hydraulic apparatus, and the living machine. In all such machines there is a central source of power, and the parts of the machine are merely passive distributers of that power. The Cartesian school conceived of the living body as a machine of this kind; and herein they might have learnt from Galen, who, whatever ill-use he may have made of the doctrine of "natural faculties," nevertheless had the great merit of perceiving that local forces play a great part in physiology. The same truth was recognized by Glisson, but it was first prominently brought forward in the Hallerian doctrine of the "vis insita" of muscles. If muscle can contract without nerve, there is an end of the Cartesian mechanical explanation of its contraction by the influx of animal spirits. The discoveries of Trembley tended in the same direction. In the fresh-water hydra no trace was to be found of that complicated machinery upon which the performance of the functions in the higher animals was supposed to depend. And yet the hydra moved, fed, grew, multiplied, and its fragments exhibited all the powers of the whole; and, finally, the work of Caspar F. Wolff, by demonstrating the fact that the growth and development of both plants and animals take place antecedently to the existence of their grosser organs, and are, in fact, the causes and not the consequences of organization (as then understood), sapped the foundations of the Cartesian physiology as a complete expression of vital phenomena. For Wolff, the physical basis of life is a fluid, possessed of a "vis essentialis" and a "solidescibilitas," in virtue of which it gives rise to organization; and, as he points out, this conclusion strikes at the root of the whole intro-mechanical system. In this country, the great authority of John Hunter exerted a similar influence; though it must be admitted that the too sibylline utterances which are the outcome of Hunter's struggles to define his conceptions are often susceptible of more than one interpretation. Nevertheless, on some points, Hunter is clear enough. For example, he is of opinion that "spirit is only a property of matter" ("Introduction to Natural History"), he is prepared to renounce animism, and his conception of life is so completely physical that he thinks of it as something which can exist in a state of combination in the food. "The aliment we take in has in it, in a fixed state, the real life; and this does not become active until it has got into the lungs, for there it is freed from its prison." ("Observations on Physiology.") He also thinks that "it is more in accord with the general principles of the animal machine to suppose that none of its effects are produced from any mechanical principle whatever, and that every effect is produced from an action in the part; which action is produced by a stimulus upon the part which acts, or upon some other part with which this part sympathizes so as to take up the whole action." And Hunter is as clear as Wolff, with whose work he was probably unacquainted, that "whatever life is, it most certainly does not depend upon structure or organization." Of course it is impossible that Hunter could have intended to deny the existence of purely mechanical operations in the animal body. But while, with Borelli and Boerhaave, he looked upon absorption, nutrition, and secretion as operations effected by means of the small vessels, he differed from the mechanical physiologists, who regarded these operations as the result of the mechanical properties of the small vessels, such as the size, form, and disposition of their canals and apertures. Hunter, on the contrary, considers them to be the effect of properties of these vessels which are not mechanical but vital. "The vessels," he says, "have more of the polypus in them than any other part of the body," and he talks of the "living and sensitive principles of the arteries" and even of the "dispositions or feelings of the arteries." When the blood is good and genuine the sensations of the arteries, or the dispositions for sensation, are agreeable. . . . It is then they dispose of the blood to the best advantage, increasing the growth of the whole, supplying any losses, keeping up a due succession, etc." If we follow Hunter's conceptions to their logical issue, the life of one of the higher animals is essentially the sum of the lives of all the vessels, each of which is a sort of physiological unit, answering to a polyp; and, as health is the result of the normal "action of the vessels," so is disease an effect of their abnormal action. Hunter thus stands in thought, as in time, midway between Borelli, on the one hand, and Bichat on the other. The acute founder of general anatomy, in fact, outdoes Hunter in his desire to exclude physical reasonings from the realm of life. Except in the interpretation of the action of the sense organs, he will not allow physics to have anything to do with physiology. "To apply the physical sciences to physiology is to explain the phenomena of living bodies by the laws of inert bodies. Now this is a false principle, hence all its consequences are marked with the same stamp. Let us leave to chemistry its affinity, to physics its elasticity and its gravity. Let us invoke for physiology only sensibility and contractility." Of all the unfortunate *dicta* of men of eminent ability this seems one of the most unhappy, when we think of what the application of the methods and the *data* of physics and chemistry has done toward bringing physiology into its present state. It is not too much to say that one-half of a modern text-book of physiology consists of applied physics and chemistry, and that it is exactly in the exploration of the phenomena of sensibility and contractility that physics and chemistry have exerted the most potent influence. Nevertheless, Bichat rendered a solid service to physiological progress by insisting upon the fact that what we call life, in one of the higher animals, is not an indivisible unitary archæus dominating, from its central seat, the parts of the organism, by a compound result of the synthesis of the separate lives of those parts. "All animals," he says, "are assemblages of different organs, each of which performs its function, and concurs, after its fashion, in the preservation of the whole. They are so many special machines in the general machine which constitutes the individual. But each of these special machines is itself compounded of many tissues of very different natures, which in truth constitute the elements of those organs. The conception of a proper vitality is applicable only to these simple tissues, and not to the organs themselves. And Bichat proceeds to make the obvious application of this doctrine of synthetic life, if I may so call it, to pathology. Since diseases are only alterations of vital properties, and the properties of each tissue are distinct from those of the rest, it is evident that the diseases of each tissue must be different from those of the rest. Therefore, in any organ composed of different tissues, one may be diseased and the other remain healthy; and this is what happens in most cases. In a spirit of true prophecy, Bichat says: "We have arrived at an epoch in which pathological anatomy should start afresh." For as the analysis of the organs had led him to the tissues, as the physiological units of the organism, so, in a succeeding generation, the analysis of the tissues led to the cell as the physiological element of the tissues. The contemporaneous study of development brought out the same result, and the zoologists and botanists, exploring the simplest and the lowest forms of animated beings, confirmed the great induction of the cell theory. Thus the apparently opposed views which have been battling with one another ever since the middle of the last century have proved to be each half a truth. The proposition of Descartes that the body of a living man is a machine, the actions of which are explicable by the known laws of matter and motion, is unquestionably largely true. But it is also true that the living body is a synthesis of innumerable physiological elements, each of which may nearly be described in Wolff's words, as a fluid possessed of a "vis essentialis," and a "solidescibilitas," or, in modern phrase, as protoplasm susceptible of structural metamorphosis and functional metabolism; and that the only machinery, in the precise sense in which the Cartesian school understood mechanism, is that which co-ordinates and regulates these physiological units into an organic whole. In fact, the body is a machine of the nature of an army, not of that of a watch or of a hydraulic apparatus. Of this army each cell is a soldier, an organ a brigade, the central nervous system headquarters and field telegraph, the elementary and circulatory system the commissariat. Losses are made good by recruits born in camp, and the life of the individual is a campaign, conducted successfully for a number of years, but with certain defeat in the long run. The efficacy of an army at any given moment depends on the health of the individual soldier, and on the perfection of the machinery by which he is led and brought into action at the proper time; and therefore, if the analogy holds good, there can be only two kinds of diseases, the one dependent on abnormal states of the physiological units, the other on perturbation of their co-ordinating and alimentative machinery. Hence, the establishment of the cell theory in normal biology was swiftly followed by a "cellular pathology" as its logical counterpart. I need not remind you how great an instrument of investigation this doctrine has proved in the hands of the man of genius to whom its development is due (Professor Virchow), and who would probably be the last to forget that abnormal conditions of the co-ordinative and distributive machinery of the body are no less important factors of disease. Henceforward, as it appears to me, the connection of medicine with the biological sciences is clearly defined. Pure pathology is that branch of biology which defines the particular perturbation of cell life, or of the co-ordinating machinery, or of both, on which the phenomena of disease depend. Those who are conversant with the present state of biology will hardly hesitate to admit that the conception of the life of one of the higher animals as the summation of the lives of a cell aggregate, brought into harmonious action by a co-ordinative machinery formed by some of these cells, constitutes a permanent acquisition of physiological science. But the last form of the battle between the animistic and the physical views of life is seen in the contention whether the physical analysis of vital phenomena can be carried beyond this point or not. There are some to whom living protoplasm is a substance even such as Harvey conceived the blood to be, "summa cum providentia et intellectu in finem certum agens, quasi ratiocinio quodam;" and who look with as little favor as Bichat did upon any attempt to apply the principles and the methods of physics and chemistry to the investigation of the vital processes of growth, metabolism, and contractility. They stand upon the ancient ways; only, in accordance with that progress toward democracy which a great political writer has declared to be the fatal characteristic of modern times, they substitute a republic formed by a few billions of "animulæ" for the monarchy of the all-pervading "anima." Others, on the contrary, supported by a robust faith in the universal applicability of the principles laid down by Descartes, and seeing that the actions called "vital" are, so far as we have any means of knowing, nothing but changes of place of particles of matter, looked to molecular physics to achieve the analysis of the living protoplasm itself into a molecular mechanism. If there is any truth in the received doctrines of physics, that contrast between living and inert matter on which Bichat lays so much stress does not exist. In nature nothing is at rest, nothing is amorphous; the simplest particle of that which men in their blindness are pleased to call "brute matter" is a vast aggregate of molecular mechanisms, performing complicated movements of immense rapidity, and sensitively adjusting themselves to every change in the surrounding world. Living matter differs from other matter in degree and not in kind; the microcosm repeats the macrocosm, and one chain of causation connects the nebulous original of suns and planetary systems with the protoplasmic foundation of life and organization. From this point of view pathology is the analogue of the theory of perturbations in astronomy; and therapeutics resolves itself into the discovery of the means by which a system of forces competent to eliminate any given perturbation may be introduced into the economy. And, as pathology bases itself upon normal physiology, so therapeutics rests upon pharmacology, which is, strictly speaking, a part of the great biological topic of the influence of conditions on the living organism, and has no scientific foundation apart from physiology. It appears to me that there is no more hopeful indication of the progress of medicine toward the ideal of Descartes than is to be derived from a comparison of the state of pharmacology, at the present day, with that which existed 40 years ago. If we consider the knowledge positively acquired, in this short time, of the *modus operandi* of urari, of atropia, of physostigmin, of veratria, of casca, of strychnia, of bromide of potassium, of phosphorus, there can surely be no ground for doubting that, sooner or latter, the pharmacologist will supply the physician with the means of affecting, in any desired sense, the functions of any physiological element of the body. It will, in short, become possible to introduce into the economy a molecular mechanism which, like a very cunningly contrived torpedo, shall find its way to some particular group of living elements, and cause an explosion among them, leaving the rest untouched. The search for the explanation of diseased states in modified cell life; the discovery of the important part played by parasitic organisms in the etiology of disease; the elucidation of the action of medicaments by the methods and the *data* of experimental physiology, appear to me to be the greatest steps which have ever been made toward the establishment of medicine on a scientific basis. I need hardly say they could not have been made except for the advance of normal biology. There can be no question, then, as to the nature or the value of the connection between medicine and the biological sciences. There can be no doubt that the future of pathology and of therapeutics, and therefore that of practical medicine, depend upon the extent to which those who occupy themselves with these subjects are trained in the methods and impregnated with the fundamental truths of biology. And, in conclusion, I venture to suggest that the collective sagacity of this Congress could occupy itself with no more important question than with this: How is medical education to be arranged, so that, without entangling the student in those details of the systematist which are valueless to him, he may be enabled to obtain a firm grasp of the great truths respecting animal and vegetable life, without which, notwithstanding all the progress of scientific medicine, he will still find himself an empiric?

At the conclusion of the address, many passages of which were received with cheers, Sir James Paget, the chairman, expressed the thanks of the Congress to Professor Huxley, remarking that by him, of all men, the medical profession were willing to be criticised.

EXPLOSIVE COMBINATIONS IN PHARMACY.

In the London *Chemists' and Druggists' Almanac*, 1880, it is stated that the addition of chlorine or a chloride, iodine or an iodide, to ammonia, give rise to the formation of the chloride or iodide of ammonia, either of which is liable to violent explosion on coming in contact with phosphorus, iodine, arsenic, olive or cod-liver oil, turpentine, etc. The addition of iodine to the compound soap-liniment and compound camphor-liniment has produced an explosion, as also a combination of a concentrated solution of iodine and iodide of potassium. An explosion is also to be apprehended from a concentrated solution of the permanganate of potassa in alcohol. Bichromate of potassa in alcohol may cause ignition. Aqua regia may cause explosions with alcoholates or essences. The mixture of tannin with dry chlorate of potassa or muriate of morphia is also dangerous. The addition of nitrate of silver to the essence of bitter almonds has also caused ignition. A mixture of the hypophosphate of lime with chlorate of potassa with the lactate of iron has been followed by an explosion. Tincture of the perchloride of iron and chlorate of potassa and glycerine in combination are also dangerous. Pills containing oxide of silver are liable to explode when they become warm. It is also dangerous to compound the golden sulphuret of antimony and chloride of sodium in pills. The mixture of glycerine or any other deoxidizer with easily reducible compounds is attended with danger.

A HYPNOTIC SEANCE.

To the Editor of the London Times:

Sir: The following account of a mesmeric, or, to use the more fashionable term, hypnotic *séance*, may be of some interest and use, especially at this time, when many doctors are going to and fro, and knowledge may be increased.

I went this afternoon, in common with several other members of the International Medical Congress, to the Waterloo Hotel, Jermyn street, whither Dr. G. Beard, of New York, had invited us to witness what he termed experiments in hypnotism, etc., on one of his "trained" (*sic*) patients. The "subject," a young man about twenty-one years old, was delivering a lecture on temperance in an alleged state of trance as I entered the room. Soon after Dr. Beard came in and proceeded to deal with the patient after the manner of mesmerists, stopping and starting his flow of words by a touch, etc. By Dr. Beard's permission, the suggestion of considering the case in the ordinary medical manner, by obtaining a good clinical history and examining into the patient's physical and mental condition, was adopted, and before any further experiments were tried Dr. Crichton Browne elicited the following facts: The "subject," a native of Edinburgh, was using an assumed name; he refused to disclose the name by which he was known when in business in that town, although told that the object in asking it was to inquire into his antecedents. He declined to answer questions of a medical nature put to him by Dr. Browne, the examination being in its result prefectly negative as to his credibility as a witness, but bringing out the positive fact that he had been conversant with spiritualism in New York, while he alleged that he had forgotten the name of the "mediums" he had sat with. With a protest from the spectators on the unsatisfactory upshot of the "case taking" thus far, Dr. Beard was requested to exhibit the phenomena we had come to see.

Various experiments were shown, which, in the opinion of the meeting, were totally valueless; and, finally, Dr. Beard,

having stated that the condition of perfect insensibility could be produced, the suggestion was made that this experiment should be tried, admitting, as it would, of the application of the fairly definite test of the infliction of what would in the ordinary state be pain, but would be, of course, on the hypothesis of the genuineness of Dr. Beard's case, unfelt. To this test the patient refused to submit. The meeting then, at the instance of Dr. Crichton Browne, unanimously expressed the opinion that in the absence of any proof of the genuineness of the alleged phenomena, with the strong probability of the "subject" being an impostor, it was useless to witness any further manifestations, and promptly dissolved itself.

A rumor that these performances might be reproduced at one of the meetings of the present congress is, we would hope, without foundation.

I am, Sir, your obedient servant,

H. DONKIN.

60 Upper Berkeley street, Portman square, Aug. 6.

SENSE OF FEELING IN BLIND CAVE-FISH.

A GENTLEMAN living near Mammoth Cave, Kentucky, lately gave to a party of visitors an exhibition of the behavior of the blind fish found in the cave. For three months the fish had been kept in a large tank built up with rocks in mimic cliffs and walls. In these fish the sense of feeling is remarkably developed. Curious cilia-like organs in the head seem to have much to do with the activity of their movements. The whole head, above and below, is destitute of scales, the naked skin extending backward on the sides to the base of the pectoral fins; the scaly part of the body above ends in a semicircular edge covering the space between the upper ends of the opercula. The skin covering the middle region of the head is smooth, but on either side is provided with numerous transverse and longitudinal ridges. About ten vertical ridges, also provided with papillæ, and similar to those on the head, are visible on the sides, extending from the pectoral fins to the tail, but are not so well defined as those on the head. The skin of the head is of extreme delicacy, and is covered by a very thin, loose layer of epithelium. The larger ridges have between twenty and thirty papillæ, many of these having a cup-shaped indentation at the top, in which a delicate filament is, in some instances, seen. These papillæ are largely provided with nervous filaments, and, as is obvious, from their connection with branches of the fifth pair of nerves, must be considered purely tactile, and the large number of them shows that tactile sensibility is probably very acute, and in some measure compensates for the virtual absence of the sense of sight. The bottom of the aquarium or tank was studded with stones, so that a fish could hardly swim rapidly, having to turn repeatedly to avoid the obstructions.

In among the pebbles half a dozen of the fish were seen swimming around, varying from two and a half to five inches in length. The largest specimen of this fish captured in late years is said to have been taken during the summer of 1871, and sold for ten dollars to a person who was so desirous of securing the precious morsel that he had it cooked for his dinner.

The exhibitor took a fish about an inch long called the *Melanura*, a minnow that has eyes, also found in the cave, and dropped it in the tank. It started for the bottom, but the blind fish had felt its presence and rushed to meet it before it reached the rocks. The minnow darted away from its ghostly enemies, dodging in among the rocks, now out into the clear water, doubling, turning with all the skill of a fish that had a good pair of eyes, and knew how to use them; but its pursuers, by some seemingly wonderful intuition, gained at every move, avoiding the obstacles, dashing through narrow lanes, and finally, after the rounds had been made several times, one of them darted ahead and seized the fish, ending the chase and the fish at the same time. The organs of feeling were so sensitive and highly organized that the instant the fish touched the water they placed the exact position of the disturber, and as it turned were enabled to follow by the disturbance in the water as it rushed along. The slightest jar on the frame caused them to start, and when a small stick was introduced into the water they noticed its approach immediately, as it pressed the particles down, the delicate waves of sound or motion moving in advance, and warning them of its exact position.

To observe the fishes and capture them in their native waters, almost perfect silence must be maintained, and the white forms will soon be seen darting to the top of the water and as quickly retreating to the cover of some adjacent ledge. Bits of bread or flies thrown on the water, however, attract them, and if a net is dexterously used the game can be secured.

PRESERVING SEEDS.

THE season for the ripening of seeds being at hand, a few words about their selection, preparation, and preservation will be acceptable to those not familiar with the art of raising them.

In the first place, only the best specimens of each kind should be saved, and all inferior ones rejected; this is easy enough with such plants as squashes, cucumbers, tomatoes, melons, etc., care being used to save only the earliest, fairest, and most perfect specimens. The seed should be allowed to ripen thoroughly before taking it from the fruit, which will require some weeks with squashes after gathering from the vine; tomatoes are placed in the sun for a few days, and melon seeds may be taken directly when the melon is fit to eat. Seeds of this nature having a fleshy pulp are usually cleaned by allowing them to ferment in water for a day or two, when the pulp will easily wash off, after which the seed is spread upon a sheet in the sunshine to dry. Sometimes the fermentation is allowed to go too far, and the seed is spoiled; hence some care and experience are needed to clean seed in this way, and some persons prefer to wash the seed directly from the pulp without fermenting; this insures good seed, but it is almost impossible to make it perfectly clean without fermenting.

The seeds of the squash and all vines, easily mix with others of the same family in the neighborhood, so that when a variety is to be kept pure and true to name, it must be planted quite remote from any others of the same family. The mixing is done by the bees, who carry the pollen from flower to flower, often a quarter of a mile. It is quite difficult to grow good squash seed near a pumpkin field for this reason, and not more than one kind of melon or cucumber can be grown in the same field, and have the seed pure.

Tomatoes, corn, and beans mix less readily, but should be kept separate by some rods when pure seed is required.

Seeds of vines keep longer if not allowed to freeze; they will preserve their vitality five or six years if kept in a warm dry place. A closet near a chimney is a good place, and since mice and rats are very fond of such tidbits as melon seeds, it will be advisable to lock them up in a tin chest or other rat proof arrangement. I know of nothing so provoking as to find some paper of choice seed all shelled out by the mice just at planting time, when it is often impossible to replace it, and when delay is always vexatious and expensive.

One of the most troublesome seeds to save is the dandelion. The heads must be clipped every day just as they begin to open and before the wind has scattered them, and placed in a bag carried in one hand to get them out of the wind; they need to be spread on a sheet in a dry loft for a few days to dry, and then the seed is rubbed out of the chaff between the hands, and cleaned by sifting; it is so very light that winnowing is very difficult and seldom practiced.

When saving seeds of beets, cabbage, turnip, etc., those who are most particular reject all but the seed grown on the leading stem. Beet seed is cleaned by thrashing, sifting, and picking over to get out the sticks; it varies much in size, and should be separated by a sieve in order to have it run evenly through the seed drill, for it is the most troublesome of all seed to sow evenly. Perhaps some inventor will discover a method of shelling out beet seeds, so that they could be sown evenly. If this could be done, one of the chief items of labor in raising beets would be greatly lightened, and a saving of more than half the seed would be effected also; for the beet seed as now sown is a pod containing two to five seeds each, and is so rough and uneven in shape as to give much trouble to sow it evenly with a drill; in fact to insure a good stand, very heavy seeding and laborious thinning are essential. If the pod could be crushed, and the seed shelled out, it could then be drilled in as evenly as any other seed.

When it is desirable to mix two sorts of corn, tomatoes, beans, etc., in order to get a new sort combining the good qualities of both, alternate rows of each kind are planted alongside, and the seed taken from either will contain more or less of the character of both; it will not be a true new variety, however, until it has been grown by itself for some years. At first it will sport more or less, and breed back to the old stock of one side or the other. It is thus that our best varieties of new vegetables are produced.

Seeds of all kinds keep best in a dry, even temperature. When to be kept in large lots they may be put in bags and hung from the ceiling of the room, to keep them from the mice. Most seeds are good for two to five years if carefully kept; onion seed, however, is very inferior after the first year, and worthless after the second. When old seed is to be used, it should be previously tested by sowing a counted lot in a hotbed or other suitable place, and counting the number of plants that come up, and noting the vigor of the plants. The plants from old seed are usually less vigorous than from fresh seed, and sometimes are so weak as to be worthless.—*W. D. Philbrick, in N. E. Farmer.*

BLACKBERRIES.

THE blackberry is not a favorite fruit with many gardeners; it is so untamable in its ways, and so fierce in its bristling array of briers, that one needs a good armor of buckskin or something tougher, or he will come off second best at every encounter with them. The blackberry, however, bears magnificent burdens of delicious fruit, and responds most generously to good culture and manuring; and if any one will take the trouble to grow them well, he will be rewarded by a crop that is easily gathered and readily sold, for the berries are so large and thick that it takes little time to fill a basket with them as compared with raspberries and other small fruits. The blackberry is not hardy enough to withstand our winter without shelter, and the canes are so stiff and brittle that they do not readily bend down, but with a little perseverance one may bring them or rather himself, to the scratch. Armed with good buckskin mittens, one may bend them down, and a man at each side will quickly load them with a little earth—very little will answer. Frequent hoeing and thinning of the canes in the summer also is needful, to prevent them from becoming a thicket of brambles; they can be cut easily by a hooked knife on a rather long handle, without touching them except in picking up the cuttings.

The soil best suited to the blackberry is a strong loam, well drained and deeply plowed; it will repay liberal manuring with bonedust and ashes; but rank stable dung should be sparingly applied, as it increases the length of the canes too much. The rows should have plenty of space—ten or twelve feet between them, and the canes should be kept between two wires at each side of the row, made fast to good stiff posts six feet high. The best proved variety is the Dorchester, nearly all the good fruit in Boston market being of this variety. The Wilson proves too soft. There is a variety grown at Bridgewater, however, called the Briton, which is said to be hardy; I doubt, however, if it will prove so after a long trial. Blackberries are a most wholesome fruit, and were thought by our aunts and grandmothers to have certain medicinal properties when properly prepared in cordials and sirups. These preparations were in very great demand in the time of the last war, and the price of blackberries went kiting in consequence. No doubt the blackberry makes a good cordial, but whether the virtue of the cordial is due chiefly to the berry or to the spirit and other ingredients, is a problem I submit to the doctors for solution. It is certainly "warming to the in'ards," and therefore good under certain conditions of very frequent occurrence in hot weather.—*W. D. Philbrick, in N. E. Farmer.*

FUTURE DEMANDS FOR WOOL.

BEFORE the war the proportion of woolen fabrics required to supply this country was, in pounds, four times greater than the number of people, while since that time it requires six times a greater number of pounds of wool to supply the population, thus making it necessary to have one-third more wool; and no man is so short-sighted as to suppose that our population is to remain stationary, or that it is to be augmented merely by the natural increase. This increase, together with immigration, is constantly at work. Our population is now over fifty millions, requiring three hundred million pounds of wool to supply it. Thirty years hence the population will probably reach 100,000,000 souls, requiring 600,000,000 pounds of wool to supply them; so that the sheep-shearing interest of this country has a bright prospect before it.

Now, put by the side of these facts one other, that when a flock of native ewes are crossed with a thoroughbred merino ram, the progeny will show an increase in the quantity of wool of from one-half to three quarters of a pound per head, and when we remember to what a great extent the demands of the sheep market must be supplied by the native or common sheep of the country, the future demands for thoroughbred merino rams is no longer a matter of doubt. Still there is one other point which should not be lost sight of in this connection. American wool can be made to compete with that of other countries even in their own markets. We should never, therefore, be satisfied with simply clothing themselves. When the fertile prairies of the West, the immense domains of the great Northwest, with the great region of country stretching on the west of the Mississippi, including the plains of the Missouri, shall have become stocked with sheep, the United States will take the same rank as a wool growing country that she has heretofore held in the production of cotton. No field is wider or richer in promise for the future than what is here opened for the intelligent American shepherd.—*Balt. Sun.*

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